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NEPHRECTOMY WITHOUT DRAINAGE FOR TUBERCULOUS KIDNEY

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FOLLOWING nephrectomy for tuberculosis of the kidney it was formerly our practice to drain the cavity from which the kidney was removed, especially if tuberculous material had escaped into the wound. A sinus which was slow to heal often formed, particularly in the debilitated patient in whom the second kidney was somewhat involved. In many instances mixed infection with suppuration occurred and undoubtedly was a contributing factor in the ultimate failure to cure the patient.

About two years ago a case of this type came under our observation. In operating, a large accumulation of whey-like fluid was found outside of the kidney and, after removing the kidney, treating the ureter and cleansing the wound as well as possible, I filled the cavity, which held more than a quart, with normal salt solution and closed the wound without drainage. The patient was greatly debilitated and had a moderate lesion of the remaining kidney. Primary union and a prompt and permanent recovery followed. The compensatory hypertrophy of the remaining kidney evidently furnished sufficient hyperæmia to destroy such infection as may have existed within its substance. Since then, in operating upon these cases, if the wound be soiled with tuberculous material the cavity is cleansed as well as possible, filled with normal salt solution and closed without drainage. I believe the normal salt solution enables material which is infected with tubercle bacilli in the attenuated state to be safely absorbed because diluted and absorbed quickly before there is an opportunity to establish favorable cultural conditions which would increase the virulence of the organisms. The normal salt solution is

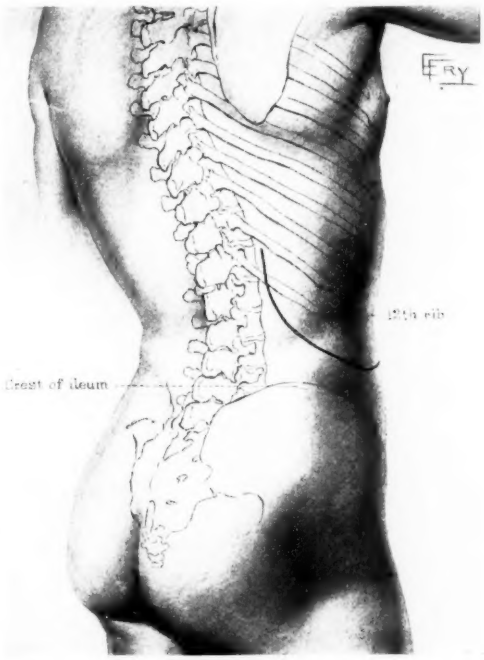

Fig. 1. Incision for exposure of kidney.

absorbed in the wound as rapidly as it would be if given in the usual manner subcutaneously.

In cases in which the tuberculous material has not escaped into the wound and the patient is otherwise in good condition, there is, of course, no necessity for using the salt solution, but drainage should not be employed.

Every effort should be made to remove the tuberculous kidney without the escape of its contents, and to secure this result an adequate incision is essential (Fig. 1). The patient is placed on the sound side with a considerable degree of elevation of the loin. A vertical cut frees the twelfth rib from its posterior attachments and a long transverse incision mobilizes the lower wall of the thorax. In this manner a large kidney can be removed with ease.

In some instances tuberculous material will have escaped spontaneously into the perirenal tissues before operation, and in such cases it will not be possible to remove the organ without distributing more or less of the tuberculous infection throughout the cavity of the wound. It is in these cases particularly that drainage has resulted so unfortunately and, I believe, has been an unnecessary procedure.

The stump of the ureter is a source of possible infection in the wound, and many surgeons either remove the kidney and ureter completely at the primary operation, or they suture the stump of the ureter to the skin for the protection of the wound.

For a number of years it has been our practice to inject 10 to 20 minims of carbolic acid (liquid 95 per cent) into the ureter. This is distributed down through the lumen, and a ureter thus treated will rarely give trouble later.

I am convinced that in draining these cases we made a mixed infection possible which was responsible for many of the post-operative conditions we heretofore believed were inherent in the process itself.

Experience has taught us that drainage following operations for tuberculous lesions within the abdomen is unnecessary and usually followed by sinus and fistula; so also have we learned that draining the cavity from which a tuberculous kidney has been removed gives rise to complications which delay or prevent healing, and which may lead to the death of the patient some months later.

INTRACRANIAL DIVISION OF THE AUDITORY NERVE FOR PERSISTENT AURAL VERTIGO[1]

By CHARLES H. FRAZIER, M. D., Philadelphia

In 1908, Dr. Charles K. Mills discussed with me the propriety of dividing intracranially the auditory nerve in a patient then under his care for the relief of an aural vertigo which had not responded to any other treatment. In 1902, Krause had proposed a similar procedure for the relief of intractable tinnitus, but so far as I know the operation had not been thought of in connection with aural vertigo, and no record appears in literature of the performance of the operation for such purpose.

The patient was admitted to the University Hospital September 19, 1908, and the following is an abstract of her history: In 1899, when fifty-five years of age, she had an attack of influenza from which she recovered, complaining of "roaring" in the left ear, and about a month later she discovered that she was deaf. In her previous history it is recorded that she had effusions in both knees and ankles, which were supposed to be of rheumatic origin, that she had typhoid fever at the age of forty-three, that two years later she had a cyst removed from the left breast, and for forty years or more was subject to nasal catarrh. Two months after the attack of influenza, immediately preceding the onset of her ailment, she began to complain of vertigo. The latter did not interfere with her sleeping, was mostly on the left side, but when sitting or standing she felt as though she were swaying forward, although she had never fallen. She always

[1]Read at the combined meeting of the New York Neurological Society with the Philadelphia Neurological Society at the College of Physicians Philadelphia, December 8, 1909.

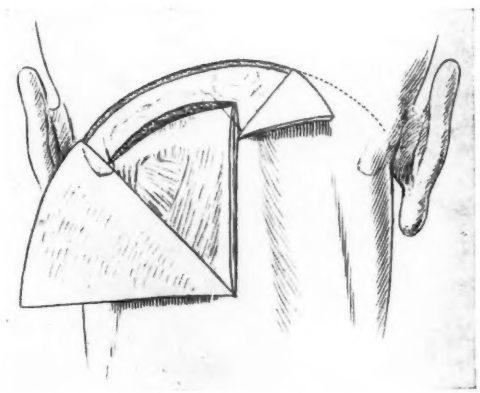

Fig. 1. Diagrammatic presentation of the position of the incision in the scalp relative to the incision in the muscular structures (suboccipital craniectomy).

Note that the incision in the muscular structure is a centimeter or two distant from the incision in the scalp.

carries the head turned toward the right shoulder. The vertigo is increased upon exertion and when she lies on the right side. There has been no sensation as if her body were being moved, and there has been no objective vertigo. In addition to the vertigo she complained of a roaring in the left ear like the noise of a sea shell. There is no headache, no ataxia, no nystagmus, no involvement of muscles supplied by the seventh cranial nerve, and no impairment of pain or touch sense in the distribution of the trigeminal nerve. The movements of the upper and lower limbs are normal, as are the patellar reflexes. Pilocarpin and adrenalin seem to aggravate the condition.

Ophthalmic Examination (Randall). Normal eye grounds, with fields entire for form and color. There is no diplopia. The pupils are active and equal, and their reaction unrestricted in all directions.

Aural Examination (Randall). Drum heads a little abnormal; hearing on right side normal for all tones. On left side, the tones are poorly heard and bone conduction seems almost absent.

The urine and blood analyses were without significance, and the systolic blood pressure was 140.

After full consideration of the gravity of the procedure and of its novelty as applied to vertigo, the patient cheerfully seconded Dr Mills' proposal, and the operation was performed October 6, 1908. Under ether anæsthesia, preceded by a hypodermic of morphine and atropin, with the patient in lateral decubitus in the reversed Trendelenburg position at an angle of 45 degrees, an incision was made as for a unilateral suboccipital craniectomy. (See Figure 1). The musculocutaneous flap was reflected downwards, without much hæmorrhage, except from an emissary sinus near the occipital protuberance. The bone was removed so as to uncover the left cerebellar hemisphere, to the left as far as the emissary vein, to the median line on the right, and above so as to expose the transverse sinus. The outer surface of the dura was unusually adherent to the bone, and its separation was a matter of considerable difficulty. The dural flap was turned down, and I at once proceeded to approach the auditory nerve, following the direction of the petrous bone as in exposure of tumors of the cerebellopontile angle. (See Fig. 2.) The left cerebellar hemisphere was gently retracted with the handle of a teaspoon, which has proven in my hands the most convenient instrument for the purpose, and every precaution taken to prevent direct or indirect pressure on the medulla or pons. Finally the internal auditory meatus was reached, and the eighth or auditory nerve

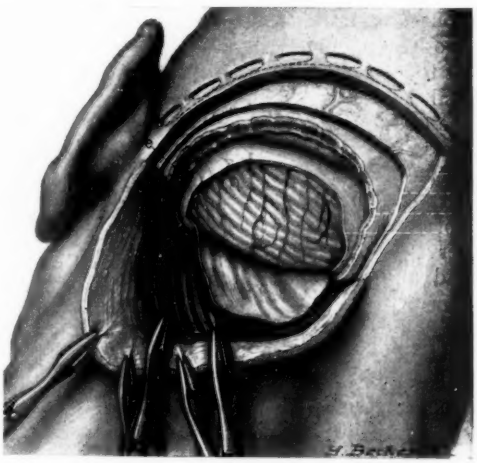

Fig. 2. Suboccipital unilateral craniectomy, showing the relative position of the incisions in the skin and musculo-aponeurotic layer to the opening in the skull and dura.

s, Heidenhain hæmostatic suture to control hæmorrhage from the superior margin of the incision. a, Cutaneous incision half an inch above b, an incision in musculo-aponeurotic layer. c, Margin of bony opening. d, Dura. e, Mastoid emissary vein.

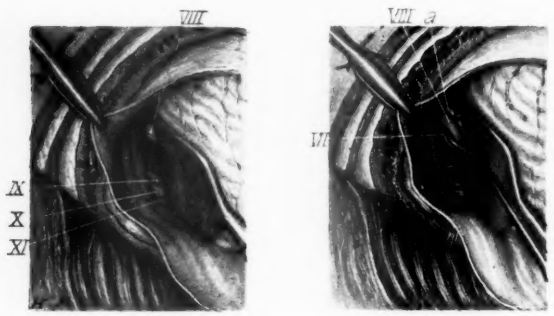

Fig. 3. (Left Figure) Illustration showing the retraction of the cerebellar hemisphere and the relation of the auditory nerve at the internal auditory meatus to the glossopharyngeal, pneumogastric, and spinal accessory nerves. Note that in this illustration the facial nerve is entirely concealed by the auditory nerve.
(Right Figure) Here the facial nerve (vii) has been separated from the auditory nerve (viii) by a blunt hook.

exposed at its point of entrance. (See Fig. 3.) After identification of the nerve, I proceeded with the most delicate feature of the operation; namely, the separation of the auditory from the facial nerve. To do this, I retracted the hemisphere so as to put the nerve on the stretch, as I had frequently seen in observations on the cadaver that by so doing the two nerves could be seen as separate trunks. As this procedure was unfortunately ineffectual, I began with a blunt hook to tease away the auditory nerve until the facial came into view, lying immediately behind it. The facial nerve was identified by applying a galvanic current. Finally, the latter was completely isolated and what remained of the auditory nerve was divided. The operation, which had lasted about an hour and a half, was concluded by closing the flap with tier sutures, a small drain being introduced through a stab opening in the middle of the flap.

It is interesting to note that, while the blood pressure was not disturbed throughout the operation, the pulse was uniformly frequent. It was recorded as 150 while the patient was being anæsthetized and remained at 140 throughout the operation. At its conclusion, the patient's condition was excellent. On the following day, the patient complained of difficulty in swallowing, and there was partial paralysis of the facial muscles, evidently the result of the trauma to the seventh nerve incidental to its isolation from the auditory nerve. This difficulty in swallowing I have frequently observed and commented upon after operations on the posterior fossa. The proximity of the jugular foramen, through which the spinal accessory, the vagus, and the glossopharyngeal nerves make their exit from the skull, to the internal auditory meatus, is such that these nerves are readily subjected to traction or to trauma in the approach to this region. Curiously enough the glossopharyngeal seems the most sensitive of the three, or if this is not the explanation, the expression of functional disturbance is more readily detected in the glossopharyngeal than in the other two accompanying nerves. The disturbance is, however, only of transitory duration and never becomes a serious complication. The facial paralysis gradually disappeared. One year after the operation, it was reported that the vertigo was only partially relieved.

The selection of cases, for which this operation is indicated, is a matter of considerable importance. If possible, those cases of tinnitus or vertigo of central origin must be excluded. The tinnitus would, of course, under these circumstances be in no wise affected by the operation. The appropriate cases are those in which the disease is labyrinthine in origin; it may originate in the cochlear ganglion, in the vestibular ganglion,

or in both, but as there is no means of separating the cochlear from the vestibular division, the auditory trunk must be divided. The most promising cases are those in which there is marked loss of air conduction, with preservation of bone conduction, cases with definite cochlear lesions, in which the tinnitus is low pitched and of varying character.

With reference to vertigo alone, some benefit might be derived from the removal of the semicircular canals, but the operation will in no way affect the tinnitus. As in the majority of instances patients so afflicted are deaf and there is no valid objection to sacrificing the auditory nerve, it would seem that where the condition has reached such a stage as to be unbearable or where the patient is absolutely incapacitated, section of the auditory nerve should be considered as a justifiable procedure, founded on sound physiologic reasoning.

To expose the auditory nerve should not be a difficult procedure for one who is accustomed to working in and familiar with the anatomical structures of the posterior fossa. There are many problems that confront one in the approach to lesions of the posterior fossa which are wholly foreign to the approach to pretentorial lesions. In the latter hæmorrhage from the scalp is readily controlled by a tourniquet, in the former other procedures must be adopted, and I have found the most effective to be a continuous overlapping silk suture, introduced one-half inch above the line of incision. This suture effectively controls bleeding from the superior margin of the curved incision. For the inferior margin, hæmostats may be applied as required,

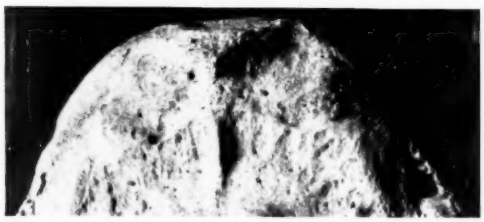

Fig. 4. In this photograph of a portion of the base of the skull below the superior curved line will be seen numerous foramina for the passage of emissary veins.

Note the size and number of these. Their presence accounts for the profuse hæmorrhage one frequently encounters in operations necessitating exposure of this region.

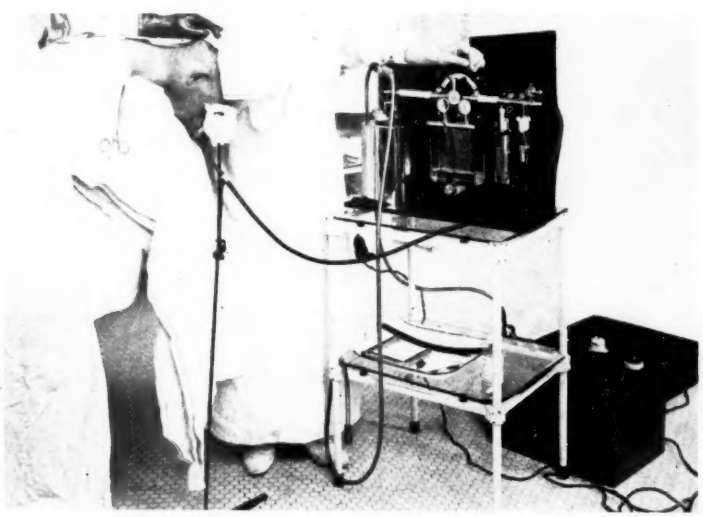

Fig. 5. Photograph of patient in the prone position, head flexed, body and shoulders elevated to an angle of 45 degrees, preparatory to the performance of a suboccipital craniectomy, showing the convenience, advantage and simplicity of the administration of ether by the method of intratracheal insufflation.

and as the flap is turned down these hæmostats will not interfere in any way with the subsequent steps of the operation. The most troublesome and sometimes serious source of bleeding are the more or less numerous emissary veins. I say more or less, as there is the most extraordinary variation with respect to the number and size of these veins in different skulls. The so-called mastoid emissary, which establishes a communication between the lateral sinus and the posterior auricular or occipital vein, is quite constant and is readily avoided, but there are often numerous other emissary veins, especially in the neighborhood of the occipital protuberance (see Fig. 4), some of large calibre, from which the blood will pour profusely until the openings in the bone are plugged with wax or, as I have had to use in some cases, with wooden pegs. A tremendous amount of blood may be lost in a very short time if hæmorrhage from this source is not promptly controlled. After the flap has been reflected and the bone removed from over one or the other hemisphere, there is no bleeding of consequence, save from a vein which passes across from the cerebellar hemisphere to enter the occipital sinus and is readily ruptured when the hemisphere is being displaced from the petrous bone. Bleeding from this vein is easily controlled by pressure.

Fig. 6. Horizontal section of the head cut on a level with the external auditory meatus.

On the left side may be seen the auditory nerve as it enters the internal auditory meatus. The illustration is particularly valuable as showing that the shortest and most practicable route to the cerebellopontile angle is from the lateral aspect following the direction of the petrous bone.

The position of the patient in suboccipital craniectomies is a matter of considerable importance. In order to secure a ready approach and proper exposure of the structures of the posterior fossa, the patient must lie on his side or on his face with the head flexed. I have been in the habit until quite recently of placing the patient on the side in the reversed Trendelenburg position, as I found that ether anæsthesia was not well borne, especially by patients with cerebellar lesions, when in the prone position. The introduction of intratracheal anæsthesia has quite revolutionized this phase of the operation, and as a matter of convenience I now place the patient in the prone position, with the head of the table elevated sufficiently to minimize the tendency to venous hæmorrhage. (See Fig. 5.) To one who has had no experience with this method of administering the anæsthetic in this operation, I cannot give it too strong a recommendation. It removes at once what was a source of grave apprehension throughout the operation. As by this method the patient is supplied without any respiratory effort with sufficient oxygen for all physiologic purposes, the prone position in no way interferes with the proper oxygenation of the blood.

It is more convenient to approach the nerve from the lateral aspect; that is, along the petrous bone. As will be seen from the illustration (see Fig. 6), the shortest distance between the cutaneous surface and the internal auditory meatus is along the posterior aspect of the petrous bone. In displacing the hemisphere towards the median line and away from the petrous bone, one or two veins

will be torn and hæmorrhage from this source must be controlled by pressure. Apart from this, there will be no bleeding of consequence after the skull has been opened. The topography of the structures near the cerebellopontile angle should be so familiar to the surgeon that he should have no difficulty in recognizing the two groups of nerves passing into the internal auditory meatus on the one hand, and the jugular foramen on the other; into the former the auditory and facial nerves, and into the latter the spinal accessorius, vagus, and glossopharyngeal. (Fig. 3).

The final step in the operation, namely the division of the auditory nerve, requires great patience and delicacy of manipulation. The relation of the auditory nerve to the facial is such that the former almost surrounds the latter, which lies to the inner side and is wholly concealed from view. The facial may be identified by the galvanic current and by the fact that it is the smaller of the two nerves. The severance of the fibres of the facial nerve, resulting in a facial palsy, would be an unjustifiable blunder, and while the patient should be forewarned of the possibility of accidental injury to the nerve, with proper precautions and an accurate knowledge of the anatomic relations, the accident is avoidable.

While the operation was followed by only partial relief, my experience with this operation and with many others in the posterior fossa encourages me to believe that this means of relief should be resorted to more frequently in the persistent and intractable forms of aural tinnitus and vertigo. Before the operation is undertaken, however, one should determine by every means of precision whether the case falls in the category for which this form of treatment is especially applicable.

ARTHROPLASTY [1]

By JAMES M. NEFF, M. D., Spokane, Washington

PREVIOUS to 1863, the methods advocated to secure motion in ankylosed joints had for their object either the breaking up of fibrous or bony adhesions between the articular surfaces or a solution of continuity of the bone on one or the other side of the joint, and the production of fibrous union between the ends. If the first was to be accomplished the joint was forcibly manipulated and the adhesions thus separated. If these adhesions were fibrous and the manipulations repeated often enough, a movable joint occasionally resulted. In the great majority of cases, however, the improvement was only temporary and the ankylosis rapidly recurred, usually being worse after such treatment than before, especially if the ankylosis was of the osseous type.

If the second object was to be attained, an open operation was usually resorted to, and the bone exposed on one side of the ankylosed joint. It was then divided by the saw or chisel, as recommended by Barton (1) of Philadelphia, in 1826, or a section of the bone was removed, after the plan of Rodgers of New York, in 1830. In both of these procedures early and persistent passive motions were used in an effort to prevent the ends of the bone from becoming reunited by osseous tissue.

From this time until 1863 there seems to have been no advancement along the lines of new joint formation. In that year, Verneuil recommended that after the Esmarch-Rizzoli operation on the ankylosed temporomaxillary articulation, the capsular soft parts be inverted into the joint, in order to insure its subsequent mobility.

Ollier advocated the interposition of muscle flaps, but to Helferich belongs the credit for having developed the technique of these muscle implantations. About the same time, Lentz interposed a muscle flap after performing a maxillary resection.

Foederl conducted experiments on the

[1] Read at meeting of the City and County Medical Society, Portland, Oregon, December 20, 1911.

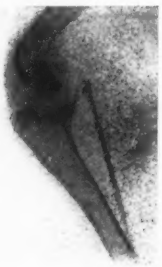

Fig. 1. Fig. 2.

Fig. 1. Radiograph showing knee in flexion.
Fig. 2. Radiograph showing knee in extension.

joints of chickens, using celluloid plates, prepared hog's bladder, and ovarian cyst wall. He found good, movable joints 52 to 96 days after operation. Encouraged by this work, Narath interposed a piece of antiseptic hog's bladder between the ends of the bones in a case of temporomaxillary ankylosis.

The most important experimental work on arthroplasty was probably done by Chlumsky (2). He performed a large number of experiments on animals, using as interposing material such foreign bodies as plates of silver, tin, zinc, celluloid, rubber, cloth and collodion. Not satisfied with his results in the use of these inabsorbable substances, he tried various absorbable ones, such as decalcified bone and magnesium. In some of the cases, after varying intervals, he found attempts at joint formation and concluded, as a result of his experiments, that magnesium plates formed the best material for use between the bone ends. Huebscher (3) and Pupovac were among the first to use magnesium plates in arthroplasties on man.

PRINCIPLES UNDERLYING THE OPERATION

In order to understand the basic principle of arthroplasty we have only to study the embryology of joints and the formation of bursæ and hygromata. We will then see that the operation was the logical outcome of such study and wonder why it was not developed earlier.

In the early stages of development of a movable joint we find the primitive cartilages separated from each other by a disc of undifferentiated embryonic mesoblastic cells. This mass of cells is closely approximated to each of the cartilages, completely filling the intervening space and being defined from the surrounding mesoblastic tissue at its circumference only by the cells being more closely packed together. The joint cavity is formed in the center of this disc of embryonic connective tissue by a degeneration and liquefaction of the cells. The cell processes become longer and thinner and the spaces between them, which contain gelatinous substance, larger and larger, until finally a distinct transverse cleft appears filled with the first synovial fluid. This synovial fluid is the product of degeneration and liquefaction of the embryonic connective tissue.

All of the joint structures develop from the cellular disc, or mass of embryonic tissue be-

Fig. 3. Photomicrograph, low power, showing condensation of tissue to form lining of bursal sac.

Fig. 4. Photomicrograph, high power. The cells and nuclei are closely packed together to form lining of bursal sac.

tween the primitive cartilages. If the cleft in the disc does not extend completely across, the portion left intact forms interarticular ligaments, while the capsular parts of the joint develop from the circumference of the disc. If the opposing articular surfaces come together only in the center, the more peripheral portions of the disc will persist as capsule, semi-lunar fibrocartilages, or as folds of synovial membrane projecting into the joint.

Instead of one transverse cleft we may have two, in which case that portion of the cellular disc between them becomes converted into an interarticular fibrocartilage. The two articular cavities thus formed may remain separate, or the intervening cartilage may become thinned in the center and perforate, thus establishing a communication between the two.

The all important fact to be learned from this brief and superficial description of the embryology is that the movable joints are formed by a "mucoid degeneration" or liquefaction of embryonic connective tissue between the ends of the articular cartilages.

HYGROMA AND BURSA FORMATION

If, bearing in mind the embryology of joints, we now study the formation of bursæ and hygromata, we find here very much the same process taking place. Under the influence of constant, or often repeated pressure, plus motion, over a fixed bony prominence, we have first a hyperplasia and hypertrophy of the underlying connective tissue. If this be fatty tissue there will be an increase in the cellular elements, a coalescence of the fatty capsules and a gradual absorption of the contained fat. In other words, the adipose tissue will first be changed into a mass of hypertrophied and hyperplastic connective tissue. The next change will be a degeneration and softening of the hyperplastic tissue in the center of the mass with the development of collagen, and lastly the liquefaction of this collagen to form the fluid which fills the cavity of the bursa. The connective tissue cells lining this newly formed cavity, under the influence of continued pressure, will flatten out and closely resemble the endothelial cells of a serous membrane. They are not endothelial cells, however, and never secrete true synovia, the bursal fluid, as mentioned above, being a product of degeneration and liquefaction of the connective tissue.

It will be noted how closely bursa formation resembles that of the normal joint, both being due to liquefaction of mesoblastic elements. An important factor in the development of bursæ, as well as of new joints after arthroplasty, is the element of motion in addition to pressure. Constant or intermittent pressure alone is not likely to result in the formation of a hygroma, whereas *pressure plus sliding motion* does tend to its production. This is illustrated in the fibrous unions of the long bones after fractures, where a bursa or "interosseous sac" only occasionally develops. Here on account of the muscular attachments and anatomical conditions present, the element of sliding motion is usually absent and the fibrous union persists, as such, without the forming of an interosseous sac. Of course where conditions are favorable, as at the end of a bone, near a joint, it does develop, but not in the majority of cases. Take, on the other hand, the elbow joint which has been the site of a bony ankylosis and in which a flap of the triceps aponeurosis has been interposed after separating the bones. Here we have pressure plus sliding motion, if the after-treatment has been properly carried out, and we can count with almost absolute certainty on a new joint forming. The element of sliding motion is also shown in the formation of nearly all of the subcutaneous and subtendinous bursæ in the body.

EXPERIMENTAL ARTHROPLASTY

Of the four experimental arthroplasties in which we used free transplants from the rectus aponeurosis, as interposing material, only one was successful. In the other three cases the result was ruined by wound infection, which caused the death of one dog and the sloughing of the transplants in the other two.

The report of the successful case follows:

Dog No. 3: Black female, weight 34 pounds. Operation, September 21, 1911. Left knee-joint exposed through anterior vertical incision, 2½ inches long. Ligamentum patellæ divided transversely and patella retracted upward. Lateral capsule of joint divided on each side, allowing the articular surfaces

to be turned into the field. The articular surfaces of both the tibia and femur were then resected by means of the saw and bone cutting forceps, special care being taken to remove every vestige of synovial membrane and articular cartilage.

A free transplant, 1¼ inches square, was then cut from the rectus aponeurosis, and used to cover the freshened joint surface of the tibia. The transplant was secured to the margins of the capsule by interrupted chromic catgut sutures. Another smaller transplant of the same tissue was sutured over the patellar surface of the lower end of the femur. The ligamentum patellæ was then reunited with chromic catgut and the skin wound closed with running catgut suture. Limb immobilized in a plaster-of-Paris cast.

The wound healed with superficial suppuration, which persisted for about two weeks, after which the dog gradually brought the foot to the ground and used the limb in locomotion.

For several weeks before the dog was killed, she had walked with scarcely any limp and flexion and extension in the operated knee were of normal extent. Lateral mobility was slightly in excess of the normal.

Dog was killed and limb amputated through the hip-joint, on January 23, 1912. X-ray pictures of the knee in flexion and extension are shown in Figs. 1 and 2. The knee was opened by a vertical anterior incision and two transverse lateral incisions, one on each side of the joint. Examination showed the following:

1. The capsule of the joint has been reformed.

2. The tibia and femur are separated by a pad of connective tissue (the transplanted rectus aponeurosis), which is firmly adherent to the bony surface above and below.

3. In the center of this connective tissue pad are two bursal sacs, each one-half inch in diameter and filled with a clear, thick fluid resembling the contents of a ganglion. These two bursal sacs are situated side by side, the outer one between the external condyle of the femur and the external tuberosity of the tibia, and the inner, between the internal condyle and internal tuberosity. It will thus be seen that the bursæ formed where the pressure was greatest.

Microscopic examination of the walls of the bursal sacs shows a fibrous connective tissue structure, the nuclei and cell bodies of which stain well. That portion nearest the bone has become vascularized and some of the blood-vessels are of considerable size. The lining proper of the bursal sacs is merely a condensation of the fibrous connective tissue, in which the cells and nuclei are more closely packed together than in any other portion. There is no evidence of flattening of lining cells. Figs. 3 and 4.

ARTHROPLASTIC METHODS

All of the various methods of performing the modern operation of arthroplasty have the following essential steps in common: 1. Exposure of the ankylosed joint by open incision. 2. Separation of the united articular ends of the bone, usually by means of the chisel and forcible movements. 3. Resection of the bony ends, either by the economic orthopedic method or more extensive resection, depending upon the case. 4. The interposition of a flap of tissue either pedunculated or free, or of some foreign material to prevent a recurrence of the ankylosis and favor the formation of a new joint. 5. Closure of the wound, with or without drainage. 6. After treatment, consisting of early and persistent active and passive motions, massage, etc.

Each of the steps except the 4th permits of but slight variation and the difference in methods therefore centers around the kind of material used to interpose between the ends of the bones.

From what has been said concerning the embryology of joints and the theory of bursa formation, the object of all methods must be the implantation or formation of connective tissue between the articular ends.

The muscle flaps of Ollier and Helferich rapidly change into connective tissue, under the influence of pressure. The fatty flaps, first advocated by Murphy, undergo the same change through the coalescence of the fatty capsules and the gradual absorption of the fat. When foreign materials are used, such as prepared hog's bladder, magnesium plates, decalcified bone, etc., they act simply as foreign bodies, preventing the bones from uniting and at the same time favoring the production of connective tissue. The substances mentioned resist absorption for a sufficient length of time to permit of a considerable amount of this tissue being formed. The action of the gold plates of Roser, the gilded aluminum plates of Orlow and the celluloid plates of Froehlich, when they are successful, is exactly the same, except that these materials are not absorbed.

M. Hofmann (5), in 1908, recommended free periosteal transplants as the best material for covering the articular ends. He performed a series of experiments on dogs, using free transplants of periosteum from the tibia, to cover the resected surfaces, suturing the flaps in such

a way that the osteoblastic layer was in contact with the freshened bony surface. When the animals were killed, 3, 7, and 12 weeks after operation, there was no ankylosis in any of the cases, and in the older ones, new formation of bone was readily observed emanating from the osteoblastic layer of the transplanted periosteum, with firm union of the latter to the underlying surface.

When periosteal flaps are successful in arthroplasty, they must act by virtue of the connective tissue in the outer or non-osteoblastic layer and therefore offer no advantages over fascial flaps. In the four cases in which Hofmann used them in the human, he succeeded in every case in preventing renewed ankylosis and in restoring motion. Here, as in all other methods, the best results were obtained where cicatricial changes in the periarticular soft parts were either absent, or present in moderate degree. He considers that the anterior surface of the tibia is best suited for the removal of large pieces of periosteum for this purpose and says that their removal is in no way injurious to the underlying bone, the defect soon being filled in with a layer of fibrous tissue.

Murphy was the first to advocate and use pedunculated flaps composed of fatty tissue on a base of fascia or muscle. He reasoned that as most of the subcutaneous bursæ are formed from fatty tissue it should be the ideal material for arthroplasty, and his results would certainly seem to bear out that opinion. He, however, makes the statement, which has been confirmed by others, that the fatty tissue always changes into connective tissue by absorption of the fat before the bursa or new joint can be formed. This would lead one to ask, what is the advantage of the fat and why not use a pure connective tissue flap in the first place, such as the capsule of the joint or the nearest available fascia; without looking further for the fat? Hoffa, who used fatty flaps in a large number of cases, considered them the best of all materials for arthroplasty. He observed that "the interposed fat gradually changed into a sort of mucous bag under the influence of pressure and motion."

Free fascial transplants were first successfully used in arthroplasty by Ritter, in 1910 (reported by Thom), in a case of ankylosis of the elbow. He took the transplant from the fascia lata of the right thigh and used it to cover the lower end of the humerus after chiseling the bones apart. The wound healed by first intention and the ultimate result was excellent, 55° of free motion being present, nine months after operation.

This, it seems to me, demonstrates the important point that the pedunculated fascial flap is unnecessary and that in many cases it is a waste of time to try to fashion one from neighboring tissues when the anatomical conditions are unfavorable.

It is ridiculous to suppose that a long flap of fascia, which is practically devoid of vessels normally, will be nourished through a pedicle, even though it be relatively wide. Lewis has demonstrated that large pieces of fascia will live when transplanted to a distant part of the body and microscopic examination weeks later will show practically no changes in their structure.

Kirschner (6) studied free fascial transplants in experimental arthroplasties and found that they became vascularized from the surrounding tissues. He reports a case of ankylosis of the patella in which he used one, but because of infection, the result was a failure.

Muscle flap interposition, first suggested by Helferich and Ollier, has since been used extensively by many surgeons, notably Bier, Quenu, Berger, Nelaton, Albarran, Delbet and Cramer. Cramer states that muscular flaps so used rapidly change into connective tissue by a process of degeneration before the new joint is formed.

Transplantation of a costal cartilage into an ankylosed elbow-joint was performed by Weglowski with good results, the patient having a range of motion of 60° to 70° after five weeks.

At least two cases are on record of autotransplantation of the entire first metatarsophalangeal joint into the elbow, for the relief of ankylosis. Both cases were operated by Buchmann (7) with good results. Nelaton and Ombrédanne used tendon flaps in the wrist with a poor result.

In 1902, Glück (8) recommended that after resection of the temporomaxillary joint, pedunculated skin flaps be interposed to prevent recurrence of the ankylosis. He reported two cases in which the method was successfully used. The employment of skin flaps to take the place of synovial membrane certainly does not seem rational, and we must have more accurate information as to the outcome of the cases in which they were used before we can place the method among those recognized for arthroplasty. At best, all we could look for would be a cutaneous cleft or depression passing between the bones and communicating with either the buccal cavity or the surface of the cheek. We could not imagine a closed articular cavity functionating like a joint and lined with skin.

Chlumsky, in 1901, reported the experiments previously referred to, finally concluding that magnesium was the best material for the purpose. The way in which it and other foreign bodies act has been already mentioned. The great objection to the use of magnesium has been commented upon by Hoffa. Its absorption is attended by the evolution of hydrogen gas, which often accumulates in the tissues in sufficient amount to cause the wound to break open and a fistula to result. Through this fistula the remainder of the magnesium is discharged and, as infection often takes place, the result is greatly endangered. Hoffa has used it once in the elbow with a fairly successful result and once in the wrist with failure.

In 1909, W. S. Baer (9) published "a preliminary report on the use of animal membrane in producing mobility in ankylosed joints." He claimed that the interposition of living tissue was followed by constant pain in many of the cases, due to pressure on the nerve endings, and that while motion might be attained by the use of muscle and fascia, it was generally unnatural and often resulted in an unstable joint. He therefore advocated the use of pig's bladder which had been chromicized to resist absorption for 40 days. Of the 8 cases in which he used the membrane 6 were successful and 2 were failures. He says that in the successful cases there is an absence of waddling, as is seen after the use of muscle or fascial flaps. The success of the operation, he says, depends on the character of the membrane used: 1. It must be absorbable. 2. It should remain intact 30 or 40 days. 3. It should be pliable enough to mold itself to the joint surface. 4. All of the raw surfaces must be covered by it. 5. The membrane must have body enough to prevent tearing. 6. It should be held firmly in place by absorbable sutures. As stated before, this membrane acts by preventing union of the bones until enough connective tissue has formed to develop a new joint. It should therefore resist absorption until this has taken place, but, as the time of absorption of this and all other prepared animal membranes is uncertain and the development of connective tissue around it is more so, the results are bound to be irregular as compared with the almost certain outcome of capsular and fascial interposition in selected cases. When for any reason such capsular and fascial flaps cannot be used, the method may have a place. Besides Baer, Osgood, Davis and Duran have used the membrane with success.

As stated before, metal plates, other than magnesium, have been successfully used in arthroplasty. Orlow (10) used gilded aluminum plates in two cases of ankylosis of the temporomaxillary joint with good results. Roser advocated gold plates. Kocher endeavored to produce sufficient connective tissue between the resected bones without the interposition of any material, by simply keeping the ends separated for a considerable length of time after operation. In this way, he succeeded in securing some motion in a few cases. De Amezaga (11) accomplished the same object in a little different manner. After resection of the elbow joint he packed the space between the bones with gauze until granulation tissue formation was well under way. He then approximated the bones of the forearm to that of the arm, hooking the ulna around the lower end of the humerus. The result was excellent, 114° of motion and a very useful joint being secured.

From even a superficial study of the theory of the operation and of the various methods proposed to produce permanent and useful motion in ankylosed joints, two points are

clear. The *first* is that a pad of connective tissue must be present between the bony ends before the bursa, or new joint, can be formed and the *second* is that the simplest, quickest and most direct method of accomplishing this must be the method of choice. This being the case, there can be no doubt that the interposition of the joint capsule or a flap of fascia, either pedunculated or free, constitutes the ideal operation of arthroplasty. All other methods are indirect and should be used only when those just mentioned are for any reason not applicable.

INDICATIONS

The operation is indicated in:

A. Bony ankylosis of the wrist, upper and lower radioulnar articulations, elbow, shoulder, temporomaxillary joint, hip and knee. Also in bony ankylosis of the smaller joints of the hands and fingers where functional impairment demands relief. This type of ankylosis may follow any of the hæmatogenous. traumatic, extension, or so-called idiopathic forms of arthritis of the dry, fibrous, serous, suppurative or ossifying types.

B. Certain unreduced fractures and dislocations. These may demand first bloody or bloodless reduction and then arthroplasty or, in long-standing cases, with great deformity, more or less extensive resection and arthroplasty.

C. Fibrous ankylosis that has resisted conservative measures, such as repeated breaking up of adhesions, persistent passive motions, etc. The majority of these cases can be cured by conservative means but in the ones that do not yield, arthroplasty is indicated. Fibrous ankylosis may follow the same pathologic processes as were mentioned above.

D. Finally, arthroplasty may be indicated where no ankylosis exists but where on account of disease or deformity of the joint, or the articular ends of the bones, a resection is demanded. Here we sacrifice the joint and form a new one, by means of arthroplasty. As examples may be mentioned: Tuberculosis of the articular ends of the bones and deformities of various joints, such as arthritis deformans and bunion.

CONTRA-INDICATIONS

A. Scudder (12) thinks that in ankylosis of the elbow, under the age of union of the epiphyses to the diaphyses, the operation should not be done because of danger of interference with the growth of the bones.

B. Huguier (13) does not consider youthfulness an objection but prefers not to operate in old age.

C. Reiner (14) says that after severe fractures and dislocations immediate resection should never be done. One should wait until the power of regeneration of the periosteum for new bone has ceased to exist and then operate.

D. The arthroplastic operations should not be performed during the progress of active pathologic conditions in the joints, but should be delayed until such have subsided. There are two reasons for this. In the first place, we never know just how far the disease will progress, nor how much destruction of the joint will take place. The process may stop before the articulation is destroyed and leave a good serviceable joint. In the second place, if we operate while the disease is active, the result may be ruined, due to an extension of the disease beyond its original limits, necrosis of flaps or suppuration of the wound. This is especially true in tuberculosis and septic diseases of the joints. It is always a safe rule to wait until the acute and subacute stages of the original lesion have subsided and the joint is left stiff. It is not, however, always necessary to wait, as for instance, in tuberculosis, the disease may be symptomatically cured and yet an encapsulated focus remain in one or more bones. Here an arthroplasty may be done and the focus removed at the time of operation.

E. Extreme and permanent atrophy of the muscles that formerly moved an ankylosed joint may be a contra-indication to the operation. This atrophy may be the result of prolonged disuse, pressure myositis from casts, bandages, etc., or paralysis, either central or due to injury of the nerves. In these cases resection and placing the joint at a more favorable angle for subsequent bony union is preferable to a flail and useless joint.

F. Another occasional contra-indication to

arthroplasty is a bony ankylosis where the skin is stretched tightly over the articular ends of the bones without any subcutaneous fatty tissue intervening. In these cases, the skin may not stand the extensive dissection necessary, and sloughing may result.

Sinuses communicating with the joint, bones and subcutaneous tissues, or diseases of the skin overlying the joint which render asepsis impossible, may also be counted as contra-indications to the operation.

A CONSIDERATION OF THE INDIVIDUAL JOINTS

The elbow-joint. From my experience and a careful study of the literature, I would unhesitatingly place the elbow-joint first in the list of those favorable to the operation. The reasons for this are evident. The elbow is a typical example of a ginglymus diarthrosis or hinge-joint, formed by the humerus above and the radius and ulna below, the latter two bones being bound firmly together by the orbicular ligament. The joint bears no weight, only as much traction as the owner sees fit to put upon it, and is characterized by a hooking of the olecranon process around the trochlea of the humerus. This hooking of the ulna, together with optional traction and the absence of weight bearing, means that comparatively thin and pliable ligaments are sufficient to hold the bones together. This combination and the fact that the joint possesses minimum articular surfaces and maximum mobility makes it an ideal one for the operation of arthroplasty. The steps in what seems to me the simplest and most rational method for arthroplasty on the elbow are as follows:

1. A median posterior incision with the elbow in extension, beginning 4 inches above the tip of the olecranon process, and terminating 2½ inches below it. The incision goes down to the triceps aponeurosis.

2. Dissection of the skin flaps on each side of the incision from the triceps aponeurosis, the condyles of the humerus and the olecranon.

3. Isolation and retraction of the ulnar nerve to the inner side.

4. Incision of the capsule laterally and posteriorly close to its attachment to the radius and ulna, thus exposing the line of union of the bones.

5. Transverse division of either the olecranon process or of the triceps tendon near its insertion, or the displacement of the tendon to one or the other side in order to gain access to the joint. At the present time, most operators prefer to leave the tendon and process intact and work around the tendon by displacing it from side to side.

6. Separation of the bones composing the joint through the line of union. This is usually done by means of the chisel and mallet supplemented by forcible movements.

7. Reforming the articular ends of the bones by means of the bone-cutting forceps, in other words, doing an economic orthopedic resection, shaping the bones as nearly as possible after their original conformation. It is essential, in doing this, that sufficient bone be removed, so that when the flap is interposed the movements of the joint will be free and unhampered, and yet too much bone must not be removed, else the joint will be flail and the lateral mobility excessive. One must strike a happy medium, and this can be learned only by experience. All exostoses and irregular marginal growths of bone must be removed at this time and it is well, while doing this, to frequently consult the radiograph, so that no fragments will be left.

8. Interposition of material between the ends of the bones. As stated before, I believe that the joint capsule, or a flap of fascia, forms the best material to interpose between the bones. If there be sufficient capsule it is the material of choice, as it is near at hand, adherent to the margin of one of the articular surfaces and most easily manipulated.

If it were intended to use the capsule, it should have been divided at its attachment to the radius and ulna laterally and posteriorly as low as possible and dissected upward from the bones to the line of its insertion into the humerus. The capsular flaps thus formed should be inverted into the joint and sutured together in the median line and also secured to the anterior portion of the capsular ligament, which has been left intact. In this way, the entire lower or articular end of the humerus is covered with capsule. If the upper

radioulnar joint is ankylosed a flap from the orbicular ligament should be interposed between the radius and ulna and sutured in place.

If the capsule be insufficient in amount to cover the lower end of the humerus, it is best to use a flap of the triceps aponeurosis, and this will probably be the method adopted in the majority of cases. The flap, taken from the superficial triceps fascia, should be 4 to 5 inches long and 1¼ to 1½ inches wide. It may include some of the muscle fibres or subcutaneous fat, and is usually left attached by a broad pedicle just above the insertion of the triceps tendon. This pedicle is left not so much for nourishment of the flap as for fixation of one end. The long flap is carried around the inner side of the olecranon process and carefully fitted over all of the elevations and depressions of the lower end of the humerus It is then sutured with interrupted chromic catgut to the remnant of capsule around the margin of the joint and to the intact anterior portion. Where the capsule has not been utilized as interposing material, all of it except the anterior portion is removed, leaving only a rim attached to the periosteum posteriorly for fixation of the flap.

9. The bones are now allowed to come together and the alignment is noted. If the olecranon has been divided the fragments are wired, or if the triceps tendon cut, it is sutured with kangaroo tendon. The constrictor is removed and hæmorrhage is controlled. This is an important point, as many otherwise perfect arthroplasties have been ruined by excessive hæmorrhage after the wound has been closed. After the hæmorrhage is controlled, the skin wound is closed with silkworm gut and horse-hair and a cast applied in either flexion or extension. If the olecrannon process or triceps tendon has been severed, extension is the better position to prevent undue tension; otherwise, flexion has the preference.

Some authorities advocate putting a Buck's extension on the forearm for a week or ten days after the operation, but this does not seem necessary. After about eight days, active and passive motion and massage are begun and continued several times a day thereafter. This after-treatment is just as important as the operation itself, and unless persisted in faithfully failure is almost sure to result. We have only to consider the theory of bursa formation to understand the reason for this. The passive and active motions are to favor the formation of the new joint, and the massage to keep up the nutrition of the muscles.

More arthroplasties have been performed on the elbow than any other joint in the body and probably with more uniformly good results.

Hoffa (15), in 1906, collected the reports of all arthroplasties that had been performed up to that time. Among these were ten elbows reported by eight surgeons: Quenu 2, Albarran 1, Nelaton 1, Delbet 1, Murphy 2, Schanz 1, Hofmann 1, Pupovac 1. Of these ten cases there were three in which muscle flaps were used, 4 fascial, 1 fatty, 1 periosteal and in 1 a magnesium plate. In all of them, excellent results were secured, with the exception of 2 cases in which fascial flaps were used and the one where the magnesium plate was interposed. These three cases were only fairly successful. Pronation and supination after operation were mentioned in 7 of the cases. They were normal, or nearly so, in one of the muscle flaps, in three of the fascial, and in the one periosteal. They were absent in one muscle flap and of only one-half the normal extent in one of the fascial cases. In none of the cases did bony ankylosis recur.

Hoffa's own cases included seven elbows. Of these, fatty flaps were used in five, fascial in one, and a magnesium plate in one. All five of the fatty flaps gave excellent results, although in one case the motions were painful. The fascial flap was also successful, but the case in which the magnesium plate was used was a failure. In this case a fistula formed after 6 weeks and osseous growths were present between the bones 9 months after operation.

In 1905, Quenu (16) published a report of an arthroplasty on the elbow in which he interposed an aponeurotic flap from the triceps. The functional result was excellent; flexion as far as a right angle and good extension (he does not state how much).

L. Dupuy (17), in 1905, reported five elbow

arthroplasties, three of which were performed by Jeannel, one by Launay and one by Kirmisson. In Jeannel's cases, muscle flaps from the brachialis anticus were successfully used. In the first, the movements of the arm were normal a year after operation, though the power was somewhat reduced. In the second, normal movements and excellent function resulted, while in the third, the result was entirely satisfactory, though the movements were of less extent than in the second case.

In Launay's case, the operation was done for fibrous ankylosis of the elbow and a flap from the anterior ligament and brachialis anticus was used. After five months there was passive flexion of 80°, extension of 155°, with free pronation and supination.

In the case of Kirmisson, a flap from the biceps was used. Five months after operation all movements in the elbow were present and the function was good.

In conclusion, Dupuy recommends total resection of the elbow-joint and the interposition of a flap from the brachialis anticus muscle.

Scudder reported two arthroplasties for ankylosis of the elbow — one performed in 1905 (18) and one in 1907. In the first, a fatty-fascial flap was used with an excellent result. The man was able to do all of the work around his farm and there was no limitation of motion, except in pronation and supination. In the second, a flap from the triceps aponeurosis was interposed between the bones. The result was all that could be desired; full restoration of flexion and extension.

G. Pereira (19) of Brazil, in 1906, operated on an unreduced, subluxated left elbow. He resected the ends of the bones and turned in a flap from the triceps muscle. Later the functional result was almost as good as that of the other arm.

In 1907, Richard Stein (20) reported three cases of arthroplasty on the elbow, from Bier's clinic at Bonn and St. Johannes Hospital. Flaps from the triceps muscle were successfully used in all. In the first, the patient, when dismissed, had active flexion of 60°, extension of 160° and good power. In the second, there was passive flexion of 90°, extension of 135°, and the patient continued to improve after she went home. In the third, it was reported 2 years after operation that flexion and extension had been restored in the elbow and the power of the arm was unimpaired.

In 1907, Bazy (21) operated on an ankylosed elbow, using a flap from the brachialis anticus. Nine months later the movements of the operated arm were as good as those of the healthy one.

In 1909, A. Huguier reported an arthroplasty for bony elbow ankylosis following a fracture, in which he used a flap of the brachialis anticus muscle. Sixteen months after operation, the patient could touch his shoulder with the hand and extend the forearm to 150°. The functional result was excellent and he was able to follow his former vocation.

Pedro Cifuentes (22), in 1909, reported an arthroplasty for fibrous ankylosis of the elbow. He interposed a flap from the brachialis anticus muscle and secured a good functional result with normal movements, according to a report one month after operation.

Hans Reiner, in 1910, reported, from Bier's clinic, 24 cases of arthroplasty on the elbow-joint, all done by means of triceps muscle flap interposition. The indications for operation in these cases were tuberculosis, ankylosis after fractures, irreducible luxations, gonorrhœal inflammations, polyarthritis and suppuration within the joints.

Among the 24 cases there were 5 poor results, an analysis of which shows the following: One was due to extreme atrophy of the muscles of arm and forearm, passive motion in the elbow-joint ranging from 50° flexion to 140° extension. Another was a case of tuberculosis of the elbow where an extensive resection was necessary. The result was an extremely flail joint with motion ranging from 15° flexion to 180° extension. The arm was very weak and the joint positively useless. The third was a case of myositis ossificans, where the ankylosis promptly recurred after operation. The fourth was a case of ankylosis after a fracture into the elbow-joint. Nine months after operation there was motion ranging from 75° flexion to 110° extension, without pronation or supination. The arm was very weak, and the X-rays showed a new

formation of bone in the joint. The poor result was attributed to improper after-treatment. The fifth failure was evidently caused by postoperative suppuration, though it was thought to be due to too early resection after fracture, as the ankylosis recurred with considerable new formation of bone.

In the remaining 19 cases, a good functional result was obtained in all. The average flexion after operation in these cases was 43¾°, and the average extension 162¼°. Reiner's conclusions in regard to arthroplasty on the elbow-joint are: 1 That muscular interposition is the ideal method; that other tissues such as capsule, tendon, periosteum and fatty flaps, also foreign bodies, do not give such uniformly good results. 2. That immediate resection is to be avoided until the power of regeneration of the periosteum has ceased to exist. 3. That it is important to remove all bony splinters and resect all of the cicatricial capsule. 4. That healing by first intention is not at all necessary for a good result. In three of Bier's cases necrotic muscle tissue was discharged from the wound, with suppuration, and yet splendid results were obtained.

Ritter, in 1910 (reported by Thom, 23), operated on a case of ankylosis of the elbow, using as interposing material a free transplant from the fascia lata. Nine months later, the boy was able to participate in gymnastic exercises and had free mobility of 55°.

H. Wille (24), in 1911, interposed a flap from the supinator longus fascia. The result was good, flexion to 70° and extension to 165°, 3 months after operation. Pronation and supination were good, but the power was not quite normal at time of last report.

Baer mentions a case operated on by Weglowski, in which the cartilage from the seventh rib was transplanted into the elbow-joint for the relief of ankylosis. Five weeks later the patient had from 60° to 70° motion in the joint.

The case of De Amezaga was spoken of before. He used no interposing material, but, after resecting the joint, favored the formation of connective tissue between the bones by packing with gauze. The final result was flexion of the elbow to 36° and extension to 150°. Three years after operation, the patient was following her usual occupation and able to carry heavy weights.

Biermann mentions Buchmann as performing auto-transplantation of the first metatarsophalangeal joint in two cases with good results.

Temporomaxillary-joint. This was the first joint in which the operation of arthroplasty was performed, and next to the elbow already discussed, the one in which the best results have been secured. Because of its peculiar situation near a mucous membrane, it is subject to a greater variety of articular and periarticular lesions than any other joint in the body. For instance, the ulcerative conditions of the mouth, as noma in scarlet fever and other infectious diseases, burns due to caustics, infections from the teeth and abrasions of the mucous membrane, may lead either to dense pericapsular contractions or, by extension, to suppurative and destructive inflammations in the joint itself. Furthermore, on account of its deep situation beneath the zygoma and its relation to important structures, as the facial nerve, the parotid gland, the internal maxillary artery, etc., the surgical treatment of ankylosis, whether articular or periarticular, is often different from that indicated in other joints. For instance, in a case of pericapsular ankylosis following noma, we may have to be content with removing a V-shaped piece of bone from the ramus or body of the jaw, in front of the contracting band, and interposing a flap of the masseter or temporal muscle to form a new joint in an abnormal situation. This is not the operation of election, but it may be the one of necessity. In a case of this kind, we should always endeavor, if possible, to remove the cicatricial tissue from within the mouth and transplant into the defect a non-hairy pedunculated flap of skin from the neck, arm or forearm.

In articular ankylosis it will usually be possible to expose the joint and perform the operation of arthroplasty in the regular way. The joint is best exposed through a short curved incision beginning just in front of the tragus and carried upward over the zygoma.

The skin and fascia are divided down to the zygoma, ligating the superficial temporal artery and vein if necessary. In making the incision, great care is necessary to avoid injury to the orbital branches of the facial nerve, which cross the face in this situation. On reaching the zygoma, the fascia should be stripped from it sub-periosteally, when the capsule of the joint will be opened. With the chisel and mallet the condyle may now be separated from the glenoid fossa and the joint mobilized. By levering out the condyle the fossa may be curetted out and a flap from the temporal fascia or masseter muscle turned in and sutured to the capsule on the inner side. Passive and active motions must be begun early and persisted in, as in all other joints, if we expect to secure good results.

Hoffa's statistics included 18 jaw operations, which were performed by 13 surgeons, as follows: Helferich 1, Lentz 1, Mikulicz 1, Henle 1, Bilczynski 1, Kusnetzow 1, Glück 2, Rochet 4, Schmidt 1, Foederl 1, Orlow 2, Meyer 1, Beresowski 1. In 13 of these, muscle flaps were employed, in 2 skin flaps, in 1 prepared hog's bladder, in 1 a gold plate and in 1 a gilded aluminum plate. In all of the 13 muscle flap cases, a good result was secured, the average separation of the incisor teeth in 10 of the cases being 2.6 cm. In another, the mobility of the lower jaw was stated to be normal; in a second, good; and in a third, the result was not mentioned. In the two cases in which skin flaps were interposed, a maximum opening of the jaws was secured. In the case where prepared hog's bladder was used, the incisors could be separated 2 cm. after operation, and in the two in which gilded plates were interposed, 2 and 1¾ cm. respectively.

In Hoffa's personal cases there were two maxillary joint operations. In one he chiseled off the articular process on the right side and both the articular and coronoid processes on the left side, without any interposition of material. The result was very satisfactory, and the teeth could be actively separated 3 cm. without pain.

In the other case, after chiseling off the articular process, he interposed a flap of the temporal muscle. The result was excellent, the jaw being mobile to the extent that two fingers could be placed between the actively separated teeth.

Biermann, in 1909, reports from Bier's clinic at Bonn, a case of arthroplasty on the right temporomaxillary articulation. The condyle was resected and a flap from the temporal muscle interposed. The wound healed by primary union and the patient could eat like any healthy child.

Richard Stein also reports a case from Bier's clinic, in which the head was resected and a flap from the temporal muscle interposed. The result was perfect recovery of function one year later.

The hip-joint. Next in order of joints favorable to the operation of arthroplasty comes the hip. It is a typical ball-and-socket joint in which are present two of the essential conditions for success, namely, maximum mobility with nearly a minimum of necessary articular surface. Here, to be sure, we have the entire weight of the body thrown upon the joints during standing and walking, but strong thick periarticular structures and capsule are not necessary to hold the bones together, even under these conditions. This is due to the fact that the head of the femur fits accurately into the acetabular cavity and is not easily displaced, a comparatively thin capsule and slight restraining ligaments therefore being sufficient to preserve the anatomical relations of the bones. This combination of conditions, it seems to me, explains the good operative results in this joint. Here the ideal operation of preserving the head of the femur and the acetabular socket can be performed, and in only exceptional cases is it necessary to remove the head or to divide the bone through the anatomical or surgical necks, thus creating a new joint in an abnormal location. The operation is best performed as follows:

1. A U-shaped incision through the skin and superficial fascia with the base of the U upward and the great trochanter in the center of the incision.

2. Reflexion of the flap upward, leaving it attached to the base of the U.

3. Formation of a long, broad flap of the fascia lata, following along the same lines as

the skin flap with the pedicle of attachment, also upward. This flap must be of ample length and breadth to entirely cover the head of the femur, without tension, after the latter has been freed from the acetabular cavity. It may or may not include some of the subcutaneous fatty tissue.

4. Separation of the great trochanter from the neck of the femur by means of the Gigli saw. It should be sawed obliquely downward, so that a broad bony surface is left for subsequent reattachment.

5. Retraction upward of the great trochanter with the attached external rotators of the thigh. Now, with retraction of the muscles laterally we have a splendid exposure of the entire margin of the acetabulum.

6. The amount of available capsule should then be estimated and, if of sufficient length and thickness, it should be utilized for interposition. If it has been decided to use the capsule, it should be incised circularly down to the bone, as far as possible toward the trochanters, and separated from the neck with the periosteotome. When the margin of the acetabulum is reached, the capsule should be split on two opposite sides and retracted laterally.

7. The next step is the separation of the head of the bone from the acetabulum, or, in the case of complete bony ankylosis, with welding of the parts together, the simultaneous formation of a new femoral head and acetabular socket. This is best accomplished by means of a carpenter's curved chisel, the arc of the curve corresponding to the normal margin of the acetabulum. By driving the chisel in a direction downward and inward around the entire acetabular margin, the new head is roughly formed. When completely detached, it is levered out and re-formed or smoothed off by means of a bone-cutting forceps, or Murphy's new forming instrument, which consists of a steel socket, having the shape of a normal femoral head, on the inner surface of which are cutting edges. By inserting the bone into the socket and rotating the socket, the end is rounded off rapidly and perfectly. The new acetabular cavity is next hollowed out to conform to the shape of the head. This may be done with the curette or with Murphy's acetabular instrument, which is the reverse of the one just described.

8. The bony surfaces having been prepared, we are now ready for the interposition of the flap. If the capsule is used, the two flaps are simply inverted into the bottom of the acetabulum and sutured together with chromic catgut or kangaroo tendon. If there is not sufficient capsule available, the fascial flap, previously formed, is sutured with chromic gut to the margin of the capsule around the femoral head. If this method is used, the rest of the capsule is excised.

9. The head of the femur is now replaced in the acetabulum with the flap of tissue intervening and the great trochanter brought back into place. It is secured to the broad bony surface with two ordinary steel nails which reach well up into the neck.

10. The flap of skin and superficial fat is next brought down and sutured into position with silkworm gut and horse-hair. If there has been much oozing, a small rubber drain is placed in one angle of the wound and retained for 24 hours.

11. Buck's extension with 15 to 20 pounds weight is applied on the leg, and left on for 10 or 12 days.

The thigh should be kept in a position of abduction after operation, to overcome the action of the adductors. This is best accomplished by means of a hinged splint between the limbs, the distance between the lower ends of which can be increased daily if necessary. Passive motions and massage should be begun on the 8th day and persisted in every day afterward.

Hoffa's statistics include 7 hip operations for bony ankylosis performed by 3 surgeons, as follows: Rochet 3, Nelaton 2 and Murphy 2. In five of the cases, muscle flaps from the tensor vaginæ femoris, the glutei, the adductors, and psoas muscles were used and in two, flaps from the fascia lata. In none of the cases did bony ankylosis recur, but the degree of mobility following the operation varied greatly. In one of Murphy's cases, the result was perfect, splendid function and normal motion in all directions without pain. In this case the fascia lata was used. In Murphy's other case, where the fascia was

interposed, the mobility after one year was good, but the patient had considerable pain and had to use crutches. In two of the five cases where muscle flaps were used, one had mobility of 40°, one year, and the other, 45°, eight months after operation, both with fairly good function. In another, the mobility was good at first but lessened later without entirely disappearing. Two and one-half years after the operation this patient could walk well by taking short steps. Of the two remaining cases, in one an excellent result was secured. Five years after operation, the patient had good motion, could sit erect and walked with only a slight limp. In the other case there was distinct, though restricted, mobility, nine months after operation, but the functional result was poor and the patient was but little benefited.

Among Hoffa's own cases there was one arthroplasty for ankylosis of the hip, in which he used a flap of fatty tissue. Seventeen months after operation the patient had no pain and walked without difficulty. Passive motions were free in all directions, but active mobility was somewhat restricted.

Richard Stein, in 1907, reported from Bier's clinic at Bonn, a case of bony ankylosis of both hips, on which a double arthroplasty was performed. The head on each side was chiseled out of the acetabular cavity and a flap of the sartorius muscle interposed. On the right side a mild infection occurred, but the wound ultimately healed. Seven months after operation, flexion and extension in the left hip were from 15 to 20 per cent and abduction 20 per cent of the normal. In the right hip, five months after operation, flexion and extension were 30 per cent and abduction 10 per cent of the normal.

Ahrens (25), in 1908, resected the head of the femur, chiseled out the acetabulum and interposed a flap from the gluteus maximus muscle between the bony surfaces. The patient was in the hospital eleven weeks. At the time of last report, he was able to walk, without pain or fatigue, with the aid of one cane. With the pelvis fixed, he had active flexion of 80° and active extension of 170°.

W. S. Baer, in 1909, reported two cases of arthroplasty on the hip-joint, in which he used chromicized pig's bladder. The first was one of encapsulated tuberculosis of the hip, where he separated the bones and covered the femoral head with the membrane. Two months after operation, a considerable degree of abduction and adduction was present, and six months later the thigh could be flexed to a right angle.

In the second case, there was bony ankylosis of the right hip, in a position of 90° flexion and 20° adduction. The head was chiseled out of the acetabular cavity and covered with the chromicized membrane, after which the adductors were divided and the leg brought down in extension and abduction. One hundred and fifty-six days after operation there was motion to the extent of 50° flexion, 30° abduction, 10° adduction, and good inward and outward rotation.

Lopez Duran (26), in 1910, performed an arthroplasty on the hip for ankylosis due to arthritis deformans. He first did an arthrotomy and then covered the femoral head with Baer's membrane. The result was mobility of about 50 per cent of the normal.

The knee-joint. Bony ankylosis between the femur and tibia is by far the most unsatisfactory condition with which we have to deal in the formation of new joints. Indeed, the results so far achieved have been so poor that some authorities consider the operation contra-indicated when this joint is involved. The reasons for this are obvious. In the first place, the joint presents extensive articular surfaces, which lie flat one upon the other, without any bony conformation which tends to keep them together, and in the second place, the entire weight of the body is thrown upon the joints in standing and walking. Now, neither of these factors in itself would render the joint unfavorable for arthroplasty, but when we consider that, because of them, the capsule and periarticular structures must be of enormous strength and thickness, the reason is apparent. It is the tendency to form dense, thick and unyielding capsular and pericapsular structures, which are to maintain the stability of the joint, that the failures of operation are mainly due.

When the ankylosis exists between the patella and the femur, on the other hand, we have a condition which is readily and satisfactorily remedied by the interposition of tissue. Here strong periarticular structures are not necessary, and consequently there is nothing to bind or fix the new joint after it is formed.

The steps in the operation for bony ankylosis of the knee are as follows:

1. An H-shaped incision through the skin and fatty tissue down to the capsule of the joint. The vertical arms of the H are on each side of the patella and the transverse cut across its center.

2. Dissection of the skin flaps upward and downward, exposing the patella and entire region of the joint.

3. Vertical incisions on each side of the patella through the capsule. This gives one an estimate of the amount of capsule available for flaps, and when sufficient, it should always be used in preference to fascial flaps.

4. Transverse division of the capsule on each side high up on the bone, each incision extending posteriorly from the upper end of the verticular capsular incision. These divide the capsule as far back as its posterior portion, from which point other vertical incisions should be made down to the tibia. These cuts will outline the two capsular flaps, one on each side.

5. Separation of the capsular flaps with the periosteotome, from the side of the femur to their attachments on the tibia.

6. Separation of the patella from the femur by means of the chisel and mallet, and displacement of the quadriceps tendon, patella and ligamentum patellæ outwards over the external condyle of the femur (Murphy).

7. Separation with the chisel and mallet of the bony union between the femur and tibia, followed by forcible flexion of the knee to an acute angle. This throws the patella farther to the outer side and gives a complete exposure of the interior of the knee-joint.

8. Economic orthopedic resection of the articular surfaces, removing enough bone to render the movements perfectly free and yet not enough to give a flail joint. The original contour of both articular surfaces should be preserved as nearly as possible and all periarticular exostoses removed.

9. The articular surfaces having been prepared, the capsular flaps are inverted into the joint and sutured together in the median line with interrupted chromic catgut or kangaroo tendon sutures. The united flaps are then sutured to the posterior capsule and to the anterior periosteum of the tibia and the leg brought down to extension.

If there is not enough capsule from which to fashion the flaps, they should be made from the fascia of the vastus externus or internus or both, with their pedicles of attachment downward. They should then be turned in so as to cover the entire articular surface and sutured in place.

10. The patella is next twisted either inward or outward on its vertical axis, after the method of Murphy, so that its posterior bony surface faces forward and its aponeurotic surface backward. A suture in the quadriceps tendon above and in the ligamentum patellæ below maintains it in its new position.

The roughened bony surface of the femur, where the patella was formerly adherent, is now smoothed off with forceps or curette and the joint tested for passive flexion. If this is not absolutely free, at least to a right angle, the quadriceps should be stretched by careful movements or an elongation of the ligamentum patellæ performed.

11. The constrictor is then removed, bleeding controlled, and the skin flaps approximated and sutured. If oozing is excessive, a small rubber tube should be inserted in one or both angles for 24 hours. A Buck's extension with 10 or 15 pounds weight should be applied for 10 or 12 days and passive motions and massage begun on the eighth day. If only the patella is ankylosed to the femur, the union may be separated through a long median incision, and the bone twisted upon itself, as described above.

If it is not practicable to perform the twisting operation, a pedunculated flap may be made from the fascia covering the vastus internus or externus or both, interposed between the patella and femur and sutured in place.

In tibiofemoral or patellar ankylosis, where

neither capsular nor pedunculated flap methods are practicable, a complete transplant from the fascia lata or the rectus aponeurosis may be interposed between the bones.

In Hoffa's collection from the literature there were five arthroplasties for ankylosis of the knee, all performed by Murphy of Chicago. Fascial flaps were used in all with the following results:

In one case of bilateral arthroplasty on the knee-joints, the patient was able to walk without crutch or cane after operation. The mobility of the right leg was three to four inches and of left leg one inch, as shown by the arc described by the foot in active flexion and extension.

In another case there was severe postoperative suppuration in the joint, and yet bony ankylosis did not recur. There was, however, very slight motion in the joint after recovery.

In the fourth case there resulted 10° to 15° mobility in spite of slight suppuration in the joint.

In the fifth case, the patient was able to walk without crutch or cane and had 15° of mobility in the joint.

In one case of bony ankylosis of the patella, operated on by Cramer (27), in which he used a muscle flap from the vastus internus, the mobility of the patella remained permanent and active extension of the knee was restored. In another, operated by Huebscher, a magnesium plate with rounded edges and ends was interposed between the bones. Seven months later the patella was perfectly movable on a smooth subjacent surface.

Among the cases operated by Hoffa himself, there were eight tibiofemoral cases and one patellar case, all done by the interposition of fatty flaps. In the first, the final result was about 15° motion with ability on the part of the patient to walk well. In the second, the final result was 15° of painful motion. In the third case, he reported good recovery, with very little trouble beyond a slight painless limp. The fourth, fifth and sixth cases were complete failures, because of recurrence of the ankylosis. The seventh case was successful, in that the mobility was good five months after operation and the patient could walk for a long distance without cane or crutch. In the eighth case, mobility of 15° was present seven months after operation and the gait was better and more certain than before.

In the patellar case only a moderately good result was obtained, examination two years after operation showing only 10° motion in the knee-joint.

Hoffa concludes from his experience that 15° mobility in the knee is not sufficient for the extensive operation and long after-treatment required. He attributes the poor results to the shortening, contraction and atrophy of the extensor muscles, which limit the flexion of the knee, and thinks that the tendon should be lengthened by plastic operation, or the tuberosity, to which it is attached, should be chiseled off and transplanted higher up.

In a case of bony tibiofemoral ankylosis reported by Hoke and Andrews (28), in 1908, the bones were chiseled apart and a flap of tissue interposed between them. The result was 20° of passive motion in the joint. The details were not given.

M. Hofmann, in 1908, reported a case of bony ankylosis of the knee in which, after the removal of a bony wedge from the joint, he entirely covered the articular surface of the tibia with free periosteal transplants from the shaft of that bone. Eight months after operation, the patient had 12° to 15° motion in the joint, but the patella was immovable. This led to a second operation, where the patella was loosened from the femur and free periosteal transplants inserted between the bones. Even after this, the result was not satisfactory, as active mobility in the knee did not exceed 15°, the restricted motion being due to the fact that the entire joint was enclosed in a greatly thickened capsule.

W. S. Baer, in 1909, reported five cases of ankylosis of the knee treated by the interposition of chromicized pig's bladder. Three of the five cases were successful and two were failures. In the first case, the mobility was 10° at the end of thirteen months. In the second and third, there was recurrence of the ankylosis after operation. In the fourth case, where there was fibrous ankylosis between the femur and tibia and between the femur

and patella, an excellent result was obtained. Six months after operation, the leg could be brought down to full extension and flexed to 75°. There was no pain on motion and the child walked with only a slight limp. In the fifth case, a good result was also secured. There was bony ankylosis between the patella and femur as well as between the tibia and femur. After chiseling the bones apart, chromicized pig's bladder was interposed, with the result that 41 days after operation the patient could walk with the aid of a cane and bear the weight of the body on the leg. He could then flex the knee to an angle of 35° and the motion was improving daily at the time of report.

In discussing Baer's paper, Osgood reported a case of bony ankylosis of the knee, where he used pig's bladder. Considerable osseous tissue was first removed, after which he tied the membrane around the articular end of each bone. The result was 80° free painless motion in the joint.

The shoulder-joint. Ankylosis of the shoulder rarely indicates operation for its relief, for the simple reason that the movable scapula so readily follows the arm in most of its movements that fairly good function is present even in complete ankylosis of the joint.

Theoretically, it should be one of the most favorable joints in the body for arthroplasty, as it is of the simple ball-and-socket type with minimum extent of articular surface and maximum mobility, combined with thin capsule and light retaining bands to hold the bones together. The readiness with which the muscles around the joint become paralyzed and atrophic, however, detracts somewhat from the otherwise favorable conditions. The circumflex nerve, particularly, is so easily injured in all operative procedures, and the results of the injury so disastrous, that it forms one of the stumbling blocks to extensive surgery around the joint.

The shoulder-joint is best reached through an incision 3½ inches long, extending from the base of the coracoid process, and on a level with it, downward on a line with the bicipital groove. The cephalic vein lies in the groove between the fibres of the deltoid and pectoralis major, and serves as a guide in the operation. The bicipital groove and the capsule of the joint are exposed through this incision and the greater tuberosity located. The latter may now be divided by means of the Gigli saw and, with its attached muscles, retracted upward. The remainder of the operation is practically the same as on the hip-joint, either the capsule or a flap of fascia being used to interpose between the articular surfaces.

Nelaton (29), in 1903, reported a case of complete ankylosis of the shoulder, operated on by Coville. He resected the head through the anatomical neck and interposed a flap of the deltoid muscle. The result was good, the patient being able to move the arm forward and backward, actively. Abduction, however, was limited, though he does not say to what extent.

In 1908, M. Hofmann reported a case of bony ankylosis of the left shoulder, on which he performed an arthroplasty. The shoulder joint was exposed, the bones separated, and the opposing surfaces covered with periosteal transplants from the tibia. The result was excellent; one year after operation the rotary movements of the shoulder were almost normal. There was active abduction, with fixed scapula, up to 45°, after which the scapula moved with the arm.

The wrist-joint. The wrist is another joint in which arthroplasty is rarely indicated, unless the movements of the hand are seriously interfered with by the ankylosis.

The radiocarpal joint is a comparatively simple one, of the biaxial diarthrodial type, formed by the radius and triangular fibrocartilage above and by the scaphoid, semilunar and cuneiform bones below. Its function, however, is so intimately associated with that of the carpal, intercarpal, carpometacarpal and metacarpophalangeal joints that one is more or less limited without the other. Usually the radiocarpal does not communicate with the carpal joints, but, even when it does not, the thickening of the capsule consequent upon a severe radiocarpal arthritis is sufficient to obliterate the motion that normally exists between the bones of the carpus and between them and the metacarpus.

When the cavities do communicate, the pathologic process in the articulation will

extend throughout the intercarpal and into the carpometacarpal joints and destroy the synovial membrane, thus resulting in bony ankylosis.

In the cases where the operation is indicated, it is best performed as follows:

1. A convex incision with the convexity downward through the skin and superficial fat, on the dorsum of wrist, extending from the ulnar to the radial side.
2. Reflexion of the skin flap upward.
3. Division of the posterior annular ligament and retraction of the extensor tendons laterally.
4. Division of the capsule transversely, low down on the carpal bones and dissection of it upward, leaving it attached to the radius and ulna.
5. Economic orthopedic resection of the first row of carpal bones in an arched direction with the convexity upward.
6. Economic orthopedic resection of the lower ends of the radius and ulna, in an arched direction, concavity downward.
7. Inversion of the posterior capsular flap between the articular surfaces of the bones and suturing its edge to the anterior portion of the capsule. If there is not sufficient capsule, it is best, in this joint, to interpose a complete transplant from the fascia lata or rectus aponeurosis rather than try to make a pedunculated flap from the fascia of the forearm.
8. Suture of the skin flap in place, with or without drainage, as may be indicated.
9. Passive and active motions and massage beginning on eighth day, as in the case of other joints. Both the radial and ulnar arteries should be carefully protected from injury during the operation.

Richard Stein, in 1907, reported from Bier's clinic, a case of arthroplasty for ankylosis of the wrist. He did an arch-shaped orthopedic resection of the bones and interposed a muscle flap. The result two years later was good, passive mobility in the wrist but unsatisfactory function, due to the fact that the flexor tendons had previously been cut during an attempt at suicide.

Lopez Duran, of Madrid, in 1910, reported an arthroplasty for ankylosis of the wrist, in which he used Baer's membrane for interposition. The result, one month after operation, was free, painless mobility of about 50 per cent of the normal.

Hoffa records an arthroplasty for ankylosis of the wrist, reported in 1905, by Nelaton and Ombredanne (30). They resected the first row of carpal bones and interposed a tendomuscular flap. The result was poor, ankylosis recurring in four months.

Among Hoffa's own cases were two wrist-joint operations. In one, he interposed a magnesium plate, which resulted in a gas fistula after four weeks. The remainder of the magnesium plate had to be removed and the ankylosis recurred. In the other case, he resected the first row of carpal bones and interposed a fat fascia flap taken from the proximal side of the wound. Two months after operation, there was free motion of several degrees in flexion and extension. Nine months later, the patient reported very good mobility in the wrist with an excellent functional result.

Radioulnar joints. Both the upper and lower radioulnar joints have been operated on for ankylosis. Baer, in 1909, reported a case of the former joint in which there was a congenital union between the head of the radius and the ulna. He exposed the joint, separated the union and interposed chromicized pig's bladder. Three months after operation, supination was possible up to 100° but could go no farther, owing to a congenital bend in the radius.

M. Hofmann, in 1908, reported a case of ankylosis of the lower radioulnar articulation, following a fracture, in which he removed the callus, chiseled the bones apart and interposed a transplant of periosteum from the ulna. The cast was removed in fourteen days, at which time pronation and supination were normal. There was no recurrence of the ankylosis.

Metatarsophalangeal joints. In 1908, Chas. H. Mayo (31), described an arthroplastic method for treating bunion. He exposes the metatarsal-phalangeal joint through a convex incision on the inner side of the joint and dissects the bursa from the bone in a downward direction toward the toe, leaving it

Fig. 5. Case No. 1. Radiograph of right knee five weeks after operation. Patella is perfectly free.

attached to the end of the first phalanx. He then removes the enlarged head of the first metatarsal bone, cuts off the bone on the side to the level of the shaft and interposes the bursal flap between the first phalanx and the end of the metatarsal. The skin incision is then closed. At the time of the report he had operated upon 65 cases with uniformly good results.

Interphalangeal joints. M. Hofmann, in 1908, reported a case of fibrous ankylosis of two interphalangeal joints of the same hand, in which he interposed periosteal transplants from the tibia. Six weeks after operation, there was good passive but no active mobility.

On October 17, 1911, B. J. O'Neill (32) reported a case in which he operated for "hammer toe" by removing one-fourth inch from the distal end of the first and the proximal end of the second phalanx. He then dissected a flap of subcutaneous tissue from the outer side and interposed it between the bones, suturing it on the inner side. The result six months later was entirely satisfactory, the toe remaining straight and a new joint forming at the site of interposition of the tissue.

CASE REPORTS

CASE 1. Mr. A. W. D., aged 29 years, conductor; was admitted to Mercy Hospital, Chicago, October 27, 1904. Family history is negative.

Previous history. He had acute appendicitis, terminating in localized abscess three months ago; the abscess was opened and drained.

Present illness. Fourteen months ago the patient fell under a moving freight car and was rolled a distance of ten or twelve feet. The wheels did not pass over him, but he sustained the following injuries: (*a*) Severe contusion and laceration of the soft tissues about the right knee, especially on the outer aspect. The knee-joint was opened, but no bones were fractured. (*b*) Radius and ulna were

Fig. 6. Case No. 1. Two years after operation, showing operated knee in flexion.

Fig. 7. Case No. 1. Two years after operation, showing operated knee in extension and bearing weight of body.

Fig. 8. Case No. 1. Two years after operation.

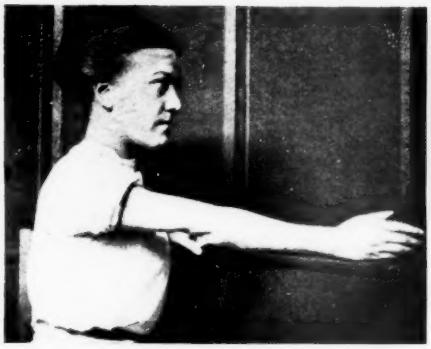

Fig. 9. Case No. 2. Seven months after operation. Operated elbow in extension. This was also the position of elbow in ankylosis before operation.

Fig. 10. Case No. 2. Seven months after operation. Elbow flexed to a right angle.

Fig. 11. Case No. 2. Seven months after operation. Operated elbow in flexion.

fractured at about the middle. (*c*) Right shoulder was severely contused. Suppuration developed in the right knee-joint, and he was confined to the hospital for eight months. When he left the hospital, the suppuration in the right knee had ceased and the wound was healed, but the patella was firmly fixed to the femur by bony union, the tibia was subluxated posteriorly, and he was unable to completely extend the leg on the thigh. Flexion in the knee was limited to 10° or 15°, and he could not support the weight of his body on the right limb. Owing to the malposition of the leg and foot during the time he was confined in bed, he had a pronounced drop foot, which added to the difficulty in walking and standing. Eleven months after the accident,

Fig. 12.

Fig. 13.

Fig. 12. Case No. 2. Radiograph of right elbow seven months after operation. Lateral view.

Fig. 13. Case No. 2. Radiograph of right elbow seven months after operation. Anterior-posterior view.

the adhesions in the right knee-joint were broken up by forcible manipulations. Since then, there has been a little more motion in the knee, but he is still obliged to use crutches in walking.

Examination. There is a scar above the right Poupart's ligament where the appendiceal abscess was drained. Where the right radius and ulna were fractured the fragments are united by fibrous tissue. Right leg is flexed on the thigh at an angle of 140° and can not be extended beyond this angle. He can flex the knee through an arc of about 20°. The muscles of the right thigh and leg are weakened from disuse. The tibia is subluxated posteriorly and the hamstring muscles permanently shortened. The patella is fixed to the femur by bony union and permits of absolutely no motion. Marked foot drop exists, the contracted posterior muscles preventing extension of the foot to a right angle.

Operation. October 29, 1904. The inner and outer hamstring tendons and tendoachilles were elongated by tendinoplasty. A U-shaped incision was made around the patella, the ligamentum patellæ divided transversely and the joint opened on each side. The capsule on each side of the patella was incised and removed, after which the leg could be flexed to a right angle without difficulty. There was bony union between the patella and femur. The capsule of the joint was thickened, the synovial membrane hypertrophied and the tibia subluxated posteriorly. The synovial membrane and articular cartilages of the knee-joint proper were normal, except anteriorly, where the capsule was adherent. The patella was chiseled free from the femur through the line of union between the two bones, and the roughened surfaces were smoothed with bone-cutting forceps. The patella was then retracted upward. A horseshoe-shaped flap, with its pedicle attached just above the knee-joint, was cut from the fascia lata covering the vastus externus, and a

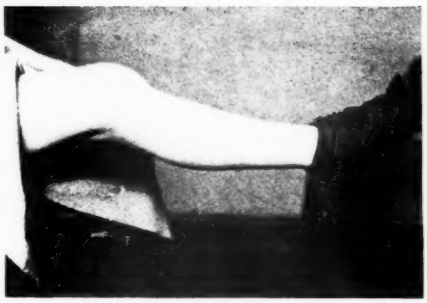

Fig. 14. Case No. 3. Ankylosed right knee before operation.

Fig. 15. Case No. 3. Radiograph of right knee before operation. Anterior-posterior view.

similar but smaller flap from the fascia, covering the vastus internus. The outer and inner flaps were then turned in between the patella and femur to cover the articular surface and their upper edges sutured to the periosteum on the anterior surface of the femur. The opposing edges were then sutured together in the median line and the lower edges to the crucial ligaments. Kangaroo tendon was used. The patella was next brought down to its normal position and secured to the ligamentum patellæ with heavy kangaroo tendon. These sutures were reinforced by others approximating the patellar aponeurosis. No drainage was used. The patient was returned to bed and the limb placed in a box.

Postoperative course. The next morning, October 30th, he complained of severe pain and tenderness in the right lower quadrant of the abdomen, and at 4 P. M. his temperature registered 102.6° F. and pulse was 136. The diagnosis of recurrent acute appendicitis was made, but operation deemed inadvisable under the circumstances. The pain and tenderness in the right iliac region subsided gradually and temperature became normal, November 12th. On November 2d, the right lower limb was placed in a straight fracture box and Buck's extension of ten pounds was applied to the leg. The wound healed by primary union and the sutures were removed November 12th. Continuous extension was used until December 2d, when the patient was allowed out of bed for the first time. The posterior

Fig. 16. Case No. 3. Radiograph of right knee before operation. Lateral view.

Fig. 17. Case No. 3. Radiograph of right knee four weeks after operation. Anterior-posterior view.

Fig. 18. Case No. 3. Radiograph of right knee four weeks after operation. Lateral view.

Fig. 19. Case No. 3. Three and one-half months after operation, showing knee in extension.

Fig. 20. Case No. 3. Three and one-half months after operation, showing knee in flexion.

subluxation of the tibia, which was so pronounced before the operation, gradually lessened under the traction and was almost entirely reduced when the extension was discontinued. Passive motions of the patella and knee, with massage, were given daily, after the first week. On December 10th, the patient was able to bear his entire weight on the limb, but used crutches in walking. The posterior subluxation was almost entirely reduced and the leg could be extended within 5° of the normal. Motion in the knee-joint was perfectly free, though somewhat limited, as a result of disuse. The patella was free from the femur (Fig. 5) and permitted considerable passive motion laterally.

Examination two years later showed a perfect result. The active motion in the knee was absolutely free and of normal range, as shown by the photographs. (Figs. 6, 7 and 8.) The knee could be extended to 180° and flexed to 35°. The power of the leg and thigh was perfectly normal, as shown by the fact that the patient had been working as brakeman on a freight train for several months. The patella on the operated side was more movable than the one on the other side.

CASE 2. Miss M. N., aged 24 years. Family history negative.

Personal history. Pneumonia at age of fourteen years. Scarlet fever when a child. Subject to moderately severe attacks of tonsilitis for several years previous to present illness. In April 1910, had a very severe attack of tonsilitis with high temperature. Was in bed three days and throat remained sore for three weeks.

Present illness. Began June 24, 1910, with pain of a sharp, shooting character in left wrist and calf of right leg. Says she felt chilly at first and later had fever and headache. The next morning pain left the wrist and leg and located in both arms, particularly in the region of the elbow-joints. Had pain all that day and the fever continued.

After about two days, the pain subsided in the left arm and located in the left knee, but at no time did it leave the right arm, which became greatly swollen and tender around the elbow and wrist. She remained in bed for two weeks, when she was taken to Hot Springs for treatment. Three weeks after onset of trouble, and while she was at the Springs, the right knee became painful, swollen, and tender. Was at the Springs for eight weeks, where she took baths and other treatment. The swelling, pain and tenderness in the right knee, elbow, wrist and hand persisted until she came to Spokane, 5 months after onset of illness. At this time the right knee and elbow were ankylosed in extension and the joints of the right wrist, hand and fingers could be moved only with great difficulty.

Examination showed: 1. The elbow firmly ankylosed in full extension. (Fig. 9.) 2. The wrist somewhat swollen, no active motion and only *slight* painful passive motion. The same applied to the metacarpophalangeal and interphalangeal joints. 3. The knee fixed in extension, permitting only one or two degrees of painful, passive motion. 4. The patella firmly united to the femur. 5. Atrophy of the muscles of the right arm, forearm, thigh and leg.

Diagnosis. 1. Bony ankylosis of the right elbow. 2. Capsular ankylosis of the right radiocarpal, intercarpal, carpometacarpal, metacarpophalangeal and interphalangeal joints. 3. Bony ankylosis of the right patella to the femur. 4. Fibrous ankylosis of the right tibiofemoral articulation. 5. Bony ankylosis of the fifth metacarpophalangeal joint.

Patient was placed in the hospital and several attempts made under anæsthesia to mobilize the knee and joints of the right wrist, hand and fingers.

After each attempt the joints were in worse condition than before. She went home for several weeks and returned to Spokane, January 15, 1911.

Operation on the right elbow at St. Luke's Hospital, Spokane, January 28, 1911. A typical arthroplasty as described above was performed. A long median posterior incision was made through the skin, the tendon of the triceps divided just above its attachment to the olecranon process; the bones chiseled apart; the articular surfaces economically resected, and a long pedunculated flap of the triceps aponeurosis interposed between the bones forming the elbow and superior radioulnar joints. The arm was placed in a cast in full extension. The wound healed by primary union. Passive motions and massage were begun on the eighth day. Convalescence was retarded by a constrictor palsy of all muscles below the elbow, which lasted for two months. Patient left the hospital on the twenty-first day, with passive motion ranging from full extension to a right angle.

On August 20th, seven months after operation, examination showed active painless motion ranging from full extension (180°) (Fig. 9) to flexion of 30°. (Figs. 10 and 11.) There was only slight lateral mobility of the joint. (Figs. 12 and 13.) The muscular power of the arm and forearm was excellent and the patient was able to carry a pail of water and perform all of her household duties. After the restoration of motion in the elbow, the mobility and function of the wrist and joints of the hand and fingers increased remarkably, so that she was hampered very slightly in her work. The mobility in all of these joints increased from practically nothing to ½ or ⅔ of their normal range. The fifth metacarpophalangeal joint alone remained rigid because of the bony ankylosis.

Case 3. Same patient as Case 2. Entered St. Luke's Hospital, August 20, 1911. At that time the right knee-joint was fixed in extension (Fig. 14) and an X-ray picture showed bony ankylosis between the patella and femur and the femur and tibia. (Figs. 15 and 16.)

Operation on the knee August 24, 1911. A typical arthroplasty as described above was performed, using the capsular flaps from each side to interpose between the tibia and femur. Instead, however, of twisting the patella, it was sawed transversely through its center at the beginning of the operation and the fragments retracted upward and downward.

When the knee-joint proper was opened, the tibia and femur were found to be united by fibrous tissue, through which were scattered areas of osseous tissue binding the bones together. The same condition was present between the patella and femur. The chisel and mallet followed by forcible movements were used to separate the bones.

After interposing the capsular flaps, a connective tissue pad was made for the patella by dissecting free a flap of aponeurosis from the under surface of the quadriceps tendon, leaving its pedicle attached to the upper margin of the bone. The free end of the flap was sutured to the anterior edge of the intercondylic notch with chromic catgut. The fragments of the patella were then united by two aluminum bronze wires and the skin flaps sutured in place.

The leg was kept in extension after operation but no weights were used. The wound healed by primary union. Passive and active motions and massage were begun on the eighth day. Patient left the hospital at the end of 3 weeks with 30° of painless passive motion, a perfectly free patella (Figs. 17 and 18) and the ability to walk a considerable distance without the aid of crutch or cane. At the present time, six months after operation, active painless mobility has increased to 45° (Figs. 19 and 20), she is able to walk all day without crutch or cane, the limb does not become fatigued, and she can dance six or seven times during an evening.

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OSTEO–ARTHRITIS OF THE SPINE

WITH A REPORT OF THREE CASES COMPLICATING DISEASE OF THE ABDOMINAL VISCERA

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OUR object in presenting this paper is to call attention to a fact which we believe has not been sufficiently considered in the diagnosis and treatment of abdominal disease. This is, that mild osteo-arthritis of the spine is often overlooked as a complicating factor.

The three cases we report occurred during the period of a year in the private practice of one of us (O'Neal) showing that the condition is not infrequent.

There are numerous examples in the literature of cases in which symptoms due to osteo-arthritis of the spine have given rise to a mistaken diagnosis of disease of the various viscera. Smith (U. S. Naval Medical Bulletin, 1908) and O'Reilly (St. Louis Medical Review, February, 1909), among others, report such cases.

Chute (Boston Medical and Surgical Journal, 1904, cli) calls attention to the frequency with which osteo-arthritis of the spine complicates genito-urinary diseases, obscuring the diagnosis and causing confusion as to the condition of these organs. He reports six cases. The probability that it occurs with greater frequency than the literature reveals, the above being the only article on this subject that we could find after a careful search, cannot be denied.

We do not intend to consider separately the special types described under the heading of Spondilitis deformans (Becterew, Strümfell, Marie types), but wish to discuss that general disease which, in its spinal manifestations, is commonly known as osteo-arthritis.

Etiology. This, at the present time, is obscure. Seventy-five per cent of cases occur in the male. The favorite time of onset is the fortieth to the fifthieth year, but it may begin at an earlier age. Gonorrhœa, typhoid fever, pockets of pus in the tonsils and around the teeth, gastro-intestinal disorders, nasal-sinus disease, faulty metabolism, trauma and exposure to heat and cold have all been assigned as etiological factors.

Pathology. Most authors describe the process as beginning in the intervertebral discs with progressive absorption and calcification, extending to the bone, resulting in apposition and fusing together of the vertebræ by bony deposits. With this there occurs proliferative changes at the edges of the bodies of the vertebræ resulting in lipping and exostoses formation. This latter may be so marked as to cause locking of the vertebræ. The disease is, however, not limited to the bodies and intervertebral discs but extends to the lateral and articular processes causing narrowing of the intervertebral foramina with pressure on the nerves and ankylosis of the small intervertebral joints. In the thoracic region ankyloses between the vertebræ and ribs occur. Involvement of the spinal ligaments also takes place. In the majority of cases these pathological changes are more marked on one side of the spinal column and tend to spread along the involved side with the result that the symptoms are more severe on that side. The process usually begins in the lumbar region and tends to spread upward involving the entire spine. As a rule,

other joints, especially those of the fingers, are attacked. Cases vary in the extent and degree of involvement and the rate of progression (Fig. 1).

Symptomatology. The disease, as a rule, is insidious in onset and chronic in course. It may, however, be sudden and acute in onset, in which case, we are inclined to believe it is an acute exacerbation of the process already existing in a mild form.

The disease ordinarily affects the lumbar, dorso-lumbar or cervico-dorsal regions of the spine. It tends, however, to involve the entire spinal column.

Pain, paresthesia, and hyperesthesia are prominent symptoms. The pain is both local and referred. Local pain is dull and aching, is always intensified by motion, and is frequently worse at night due to muscular relaxation. Local pain in acute exacerbations of the disease may be intense when the slightest movement is attempted. Acute attacks of pain simulating visceral pain, resembling those which occur in tabes, were noted in two of the cases reported below.

Urinary and gastro-intestinal pains. We have seen no mention of this in the descriptions of the disease. Referred pain is due to pressure on the nerve roots as they pass through the intervertebral foramina. On the trunk it is felt anteriorally. Its distribution depends on the region involved and it may be present in the arms, chest, abdomen and thighs. The intercostals, ilio-inguinal and ilio-hypogastric are the ones most frequently involved. We believe that this referred pain explains many cases of obstinate neuritis of the arm and occipital headache. The referred pain is frequently greater on one side than on the other, due to the greater involvement of one side of the spine in this disease, thus confusing its diagnosis with that of pain due to disease of the underlying viscera. It is felt at the ends of the involved nerves and not along their course. There may be tenderness, hyperesthesia and paresthesia corresponding to the nerves irritated.

Limitation of motion. This is always present and is most evident in flexion and lateral bending. In the latter, it is greatest toward the unaffected side. Motion occurs chiefly in the regions not attacked by the disease.

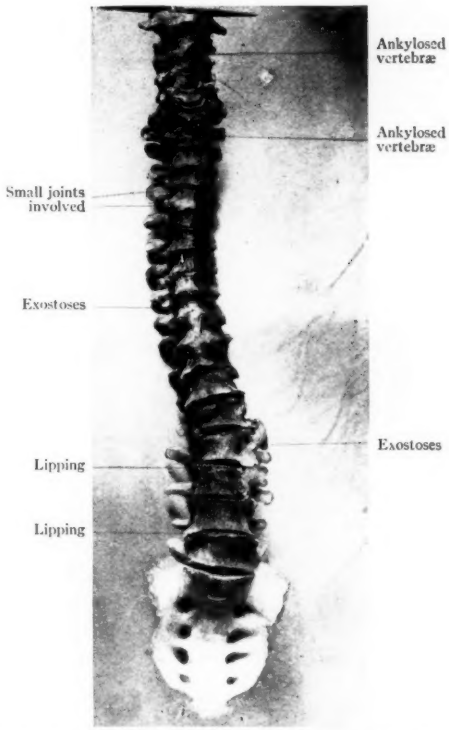

Fig. 1. Osteo-arthritis of spine. Photograph of a fairly advanced case.

Deformity. There is flattening of the lumbar curve, giving a so-called straight back. This is of frequent occurrence. A general rounded kyphosis of the middle and upper dorsal region appears in the more advanced type of cases. This double deformity results in the assumption of an incorrect standing position, the pelvis being tilted up anteriorly, the abdomen becoming scaphoid above and prominent below, with the trunk and shoulders inclined forward. This position complicates the condition by adding new features and symptoms due to the additional strain put upon an already diseased spinal column. In some cases there is lateral deviation, due to muscular spasm or an effort to get relief from pain.

Muscular spasm. This causes rigidity of the spinal muscles, which become hard and tense. It is usually more marked on one side. In the neck it may produce torticollis, as is shown in one of our cases, and in the trunk may cause lateral deviation as mentioned above.

Acute exacerbation. Intoxications, strains, or anything which lowers the general vitality of the patient will probably cause an exacerbation of the disease. Under intoxications, such conditions as pockets of pus, general infections, gastro-intestinal disorders have been mentioned. Strains will certainly cause an exacerbation and it may be a factor in the increase of symptoms following operations. The general health and nutrition of the patient is frequently impaired.

X-ray. A good X-ray picture shows the combination of absorption of lime salts or actual disappearance with osteophytes and new bone formation. Lipping of the vertebral bodies is characteristic. Narrowing of the intervertebral discs is common and exudate may be seen around the joints. This makes clear the diagnosis.

A careful search will generally reveal involvement of other joints, usually those of the hand, often the shoulder and knee.

General examination of the spine. A careful examination is necessary for the diagnosis of this disease, especially in its milder manifestations. Therefore we think that a description of the necessary methods is essential.

The back should be bared and the patient should be kept standing until the usual standing position is assumed. A plumb-line dropped from the vertebra prominens will fall normally in the crease between the buttocks and will demonstrate any lateral deformities. A plumb-line dropped from above the head, passing just in front of the external auditory-meatus normally falls just anterior to the shoulder joint, anterior to the great trochanter of the femur, through the patella and the tuberosity of the scaphoid bone. This will demonstrate any antero-posterior deviations. The undue prominence of one or both scapulæ, the difference in the heights of the two shoulders, the prominence of one hip with the accompanying depression of the flank on the same side, the prominence of the spinous processes and spasm of the spinal muscles are to be looked for. Tender joints, indurations, enlargement of the spinous processes and fluctuations can be determined by palpation. Pain or motion and the position of the greatest or least intensity of pain is obtained by flexion, extension, lateral bending and rotation of the spine.

The determination of mobility and its limitations is probably the most important part of the examination. Flexion is tested by having the patient bend forward and attempt to touch the floor with the fingers. The greater part of this motion takes place in the lumbar and last two dorsal vertebræ. Normally the chin can be made to touch the sternum. The spinous processes should make a gradual curve, the apex of which is usually in the upper dorsal region. Limitation of motion in any segment of the spine causes a break in the line of this curve. Normal lumbar curve, even in the most flexible backs, rarely disappears entirely.

Extension. The greater part of this motion occurs in the lumbar and two lower dorsal vertebræ. Extension is very limited. The pelvis must be held rigid. It is evidenced by the failure of the normal anterior curve of this region to increase and become more acute. It retains its original outline and any backward movement takes place in the hip joint. The normal rigidity of the dorsal spine should be kept in mind.

Lateral bending. This takes place almost entirely in the lumbar, lower dorsal and cervical regions. The average person can touch the knee joint by this movement. More information as to limitation of lateral bending is derived from the comparison of its extent on the two sides and the failure of certain segments to take part in this movement, than from any attempt to measure. When limited very little of the lateral bending present may take place in the part in which it should occur (lumbar), while almost the entire movement will occur in the part which naturally shows little motion (dorsal).

Rotation takes place almost exclusively in the cervical and upper dorsal region decreasing as we go down the spine. Limitation of

rotation, if hindered, is accompanied by flexion.

Jarring of the spine by having the patient come down suddenly on the heels or applying sudden pressure on their head is disappointing except in cases in which there is great destruction of the bodies of the vertebræ and extreme sensitiveness.

Differential diagnosis. The following list of diseases of the spine must be considered:

1. Tumors.
   - *a.* Sarcoma
   - *b.* Carcinoma
   - *c.* Benign
     - Fibroma
     - Osteoma
     - Enchondroma
2. Inflammations
   - *a.* Acute Osteomyelitis
   - *b.* Chronic
     - Actinomycosis
     - Syphilis
     - Tuberculosis
3. Relaxations and Static Conditions.
4. Curvatures.
5. Arthropathic
   - *a.* Tabes Dorsalis
   - *b.* Syringo Myelia
6. Rhachitis.

Sarcoma may affect the spine primarily.[1] The pain is not relieved by support and there is but slight deformity.

Carcinoma is usually secondary to cancer elsewhere.

Acute osteomylitis of the spine is uncommon. Hunt (Medical Record, April 23, 1909) reports sixty-one cases from the literature. It is similar to the same process elsewhere. Paralysis and meningitis are common from rapid extension. The lumbar region is most frequently involved. (Hunt).

Actinomycosis is uncommon. Ewing (Johns Hopkins Bulletin, November, 1902) reports involvement of the spine in only two per cent of cases. Manifestations first occur elsewhere.

Tuberculosis is the most common affection and infection of the spinal column. A disease seen most often in childhood from the third to the tenth year, but may occur from infancy to extreme old age. It differs from osteo-arthritis in being a distinctly destructive process. The early appearance of the characteristic deformity, an acute angular kyphosis, is diagnostic.

Syphilis resembles tuberculosis. It is usually accompanied by other manifestations of the disease. It may extend from the pharynx.

Relaxation and static conditions. The general relaxed condition of the patient, the forward inclination of the trunk, together with absence of any bony deformity or limitations of the spinal movement are sufficient to suggest these conditions. The pain is usually local, but is occasionally, especially in sacro-iliac relaxation and subluxation, referred anteriorly and down the legs.

Arthropathies are rare. Seen as an accompaniment of tabes and syringo-myelia.

Rhachitis is exclusively a disease of children.

Curvatures occasionally give referred pains, especially in the abdomen and along the costal nerves. The pain is usually local. The lateral deviation of the spine with the accompanying distortion is characteristic. There may be changes in the shape and density of the bone with displacement. The usual age of onset is from the tenth to the sixteenth year.

The X-ray picture, the usual involvement of other joints with the general symptomatology serve to differentiate osteo-arthritis from the above condition.

Prognosis. Changes in the bones cannot be remedied. Inflammations, however, will subside. We can promise these cases much in the way of relief of symptoms. We understand something of the etiology and many factors, either primary or those which cause exacerbations of the disease and which are now under our control.

Treatment. Time and patience are absolutely necessary on the part of the physician and the patient. We cannot emphasize too strongly the importance of seeking out and removing various sources of infection, nasal sinus disease, infected tonsils, carious teeth, gastro-intestinal disorders, these being the

[1] Wintergerst, Diss., Erlangen, 1911, reports 188 cases from the literature.

most common. They may act in two ways. Both reducing the general resistance and as a direct source of trouble. The general hygiene should be carefully watched, emphasis being placed on rest in the open air and a good general mixed diet. The elimination must be increased by hot baths and water drinking. General massage, when practical, should be tried. Internal medication is not successful. Thymus gland, as recommended by Nathan, which seems to have some effect on the nutrition of bones, should in every case be tried over long periods of time and in as large doses as possible, thirty to forty grains a day. The therapeutic limit is nervousness and gastro-intestinal disturbances. Contrary to the general opinion, the joints should be supported and partially immobilized, the aim being to reduce motion as far as is necessary to prevent symptoms, yet leave sufficient freedom so as to avoid stiffness and ankylosis. This is secured by some form of spinal support suitable to the case. Local nutrition may be improved by hot and cold douches, dry heat, high-frequency currents and local massage.

CASE 1. Mrs. B., age 50 years, housewife; first seen June, 1910. She then complained of pain in the upper right quadrant of the abdomen, and indigestion and pain in the back. The family and social history is negative. In childhood there is a history of whooping cough and measles, chickenpox and scarlet fever. No history of typhoid fever. Had malarial fever at the age of twenty. Twenty years ago an amputation of the cervix for pains in the groins and general weakness was performed. For a time she seemed benefited. Afterward another physician treated her for ovarian troubles over a period of twelve years.

Present illness. Twenty-six years ago, after the birth of her first child her back began troubling her. Pain was worse at times but never severe enough to cause her to go to bed. In addition, general abdominal pain and pain down the arms and legs was constantly present.

For many years she has had pains, apparently in the bladder, and numbness of the arms. A torticollis has been noticed for ten years. If the patient turns her head to the right it becomes flexed. This movement is somewhat painful. She has suffered with indigestion for several years. Lately has had dull pain around the gall-bladder, which radiates to the back. Nausea, but no vomiting. No jaundice or chills. Slight temperature, never above 100°.

Examination. This gives tenderness over the region of the gall-bladder, worse in inspiration. Operation, June 9, 1910, revealed six large gallstones, no adhesions or no pancreatitis was demonstrable. There was a marked visceroptosis. From this operation she made an uneventful recovery. After the operation she complained of pain in the back and generally over the abdomen. This suggested an examination of the spinal column, as the operation revealed no cause for these symptoms.

Examination of the spine. There was present a slightly rounded kyphosis of the dorsal region. There was some flattening of the lumbar spine. The abdomen was pendulous below and flat above. There was tenderness over the lower lumbar vertebræ and in the cervicodorsal region. Forward inclination of the trunk was present. Flexion markedly limited and painful. Limitation of lateral bending on both sides, particularly toward the right side. Rigidity of the cervical region was present, with slight torticollis. Pain was present when the spine was rotated. There was enlargement of the ends of the phalanges and stiffness of the phalangeal joints.

An X-ray picture of the lumbar and thoracic vertebræ showed lipping and more or less fusing together in the lumbar region and to some extent in the dorsal spine.

Résumé. Osteo-arthritis of the spine was diagnosed. This case shows long duration, twenty-six years, of the symptoms referable to the spine with gradual increase in severity and the increase of symptoms after the operation on the gall-bladder.

We believe that the pain in the abdomen was due to both spinal and visceral lesions, the gall-bladder furnishing the local pain, the spine the general abdominal pain and pain in the arms and legs. The occurrence of a torticollis in this case is due to her spinal condition.

CASE 2. Mrs. J. R., age 60 years, housewife; first seen February, 1911. Family history negative, except that one uncle had chronic rheumatism for many years. The social and previous medical history is negative.

Present illness. For the past six years patient has had backache and pain in the left groin. In 1907 she was operated upon for cystocele and rectocele on account of loss of support in this region. After the operation she complained of a sudden irresistible desire to urinate and the pain in the left groin increased. The examination of the urine was negative. The pain came apparently from the left kidney region and shot down into the left groin. There was superficial tenderness over this area. Later she admitted of pain less severe in the right groin and down both legs. This condition persist-

ing, a pelvic examination was made and tenderness was elicited over the left obturator foramen and the diagnosis of obturator neuralgia was made. A suspicion of a kidney lesion suggested an X-ray examination, which proved negative as to the kidney, but showed signs of osteo-arthritis of the spine. Examination of the back was accordingly made and revealed the following: A general rounded kyphosis of the dorsal region of moderate degree with increase of the forward inclination of the trunk and slight flattening of the lumbar spine. No lateral deviation was noted. There was some rigidity of the spinal muscles on both sides. The usual depression over the fifth lumbar vertebræ was more pronounced. Flexion was limited and the whole spine showed rigidity. Lateral bending was limited on both sides and bending toward the left was decidedly painful. Extension gave relief. The hands showed enlargement of the phalanges and stiffness of the phalangeal joints.

The X-ray picture showed involvement of the dorsal and lumbar spines with the characteristic changes.

Résumé. The diagnosis of osteo-arthritis of the spine was made. This case shows the duration of spinal symptoms for about six years. The plastic operation relieved the patient of her feeling of loss of support and frequency of urination, but had no effect on the symptoms due to the spinal conditions, pain in the groins, back, down the legs and the sudden desire to urinate.

CASE 3. Mrs. J. A. E., age 43 years, housewife; first seen March, 1910. Chief complaint, backache, pain referred to the bladder. Family history negative except grandmother had "chronic rheumatism."

Previous medical history. One child. For many years has had frequent colds, attacks of nasal sinus disease and tonsilitis. Six years ago had a hammer toe removed.

Present illness. When first seen had backache and attacks of pain, radiating to the groin and bladder. The urine examination showed pus, blood and gravel. The attacks of renal colic continuing, an X-ray of the kidney region was taken, giving negative results. In addition the patient had an acute attack of frontal and antral sinusitis. The kidney conditions improved for several weeks but on June first she was again seized with attacks of renal colic. On June 22, 1910, an X-ray revealed a stone in the right kidney but no spinal disease was reported. Cystoscopic examination revealed a colon bacillus infection of the left kidney. On June 27th a stone was removed from the right kidney by operation (O'Neal). On July 5th the patient was seized with a sudden attack of pain radiating down the right groins and outer side of the right thigh. There was a superficial tenderness and feeling of numbness which persisted until the present day. Urine from the left kidney showed colon bacilli until December, 1910. After this the patient continued having pain referred around the lower ribs and the bladder. In March, 1911, a plastic operation on the perineum and a ventrosuspension was performed for an adherent retroversion and an old perineal laceration (O'Neal). The symptoms, a sense of loss of support, were relieved. A few weeks previous to this the patient had complained of a pain in the rectum which had no relation to defecation but came on at night. A rectal examination revealed no local cause. The patient made an uneventful recovery from the operation but had pain in the back and left side at intervals. On June 3d, after a long drive and much overexertion, the patient was suddenly seized with intense abdominal pain, radiating from the spine, nausea, and pain in the bladder and rectum. Examination of the urine and feces revealed no abnormality. In addition the patient complained of pain down her left arm and left shoulder. It was first elicited at this time that for six years she had had backache, relieved by rest, and on this account, these symptoms were referred to a possible spinal condition.

An examination of the back revealed the following: There was a slight deviation of the spine to the right. No anteroposterior deformity was present. On palpation, the spinous processes of the last two dorsal and first three lumbar vertebræ were thickened. There was local tenderness over this region. There was a slight rigidity of the right spinal muscles, but marked on those of the left. In forward bending the spine was fairly flexible, except in the lower dorsal and upper lumbar region, where there was moderately marked rigidity. In forward bending the patient complained of pain, radiating from the spine around the lower border of the ribs and in the left groin.

Lateral bending was fair to the left but much limited towards the right side. The left spinal muscles became very tense and patient said she felt as if something were tugging when she attempted to bend to the right. This motion occurred in the lower dorsal region and was higher up when she attempted to bend to the right. Hyperextension was present and gave little relief. The X-ray showed osteo-arthritis of the lower dorsal and lumbar region of the spine. Since this time whenever the patient overexerts herself or strains her back there is a return of these sudden crisis-like attacks of pain over the lower ribs, back and groin on the left side and in the bladder. In July, 1911, during an attack of nasal sinusitis and tonsilitis, a swollen, red and tender joint on the little finger of the right hand appeared, which gradually subsided. In October, 1911, two diseased tonsils were removed, in addition the anterior end of both middle turbinates. Following the operation the symptoms referable to the spine were greatly increased and the spine was very tender.

Résumé. We have in this case five conditions giving symptoms. A stone in the right

kidney, an infection of the left kidney, a relaxed perineum and a retroversion and an osteo-arthritis of the spine. We believe much of the pain in the region of the left kidney, in the right groin and outer side of the thigh, the attacks of pain in the abdomen, bladder and rectum, and down the left arm were due to an osteo-arthritis of the spine. To account for this we have as a source of infection, nasal sinus disease and markedly diseased tonsils. After each operation there was a decided increase in symptoms referable to the spine. After all these operations symptoms still persisted, although each was a success and relieved well marked pathological conditions. The spinal condition explains those not relieved. This case also shows well marked spinal crises due to exacerbation of the osteo-arthritis process.

CONCLUSIONS

We wish to summarize the information obtained from the study of these cases.

1. The long duration of the symptoms, twenty-six, six and six years respectively with slight increase in their severity. Symptoms were usually worse after operations.

2. Confusion arose from the presence of both vertebral and visceral symptoms.

3. The two often exist in combination and spinal disease may simulate disease of the abdominal viscera.

4. Disease of the vertebræ gives us symptoms acute and in two of these cases referable to the urinary and gastro-intestinal tracts which resemble acute conditions and may be properly called crises, although there is no disease of the cord itself demonstrable.

5. The abdominal condition having been improved by operation or otherwise, symptoms referable to the spinal disease will often remain and confuse us as to the condition of the viscera.

6. That in diagnosing disease of the abdominal viscera no examination is complete without a careful inquiry into the condition of the spinal cord and spinal column, including an X-ray, which generally clears up the diagnosis of osteo-arthritis.

AN EXPERIMENTAL STUDY OF THE PLACENTA UNDER PHYSIOLOGICAL AND PATHOLOGICAL CONDITIONS (FERMENTS: "VITAL" STAINING) [1]

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IN the higher mammals, the material needed to supply the growing fœtus reaches the ovum through the medium of the placenta, or, before this special organ is formed, by way of the diffuse chorion, which is its precursor. The fœtal waste products traverse this same route in a reverse direction. Certain evidence obtains, moreover, that some part of this exchange continues to take place through the rest of the fœtal coverings, the amnion, even after the placenta is fully developed.[2]

The literature bearing upon fœtal metabolism and exchange is so voluminous that no effort at completeness can be attempted in this paper. Only such articles as bear directly upon questions under discussion will be referred to.

Although the placenta of the human species is of chief importance in this connection, experimental researches have necessarily been most frequently conducted upon animals; and as great and fundamental differences in structure, probably accompanied by variation in function, exist in different species, certain anatomical peculiarities must be borne in mind.

[2] Zuntz, N., Pflüger's Arch. f. Physiologie, 1878, xvi, 548, ascribes the amniotic fluid to maternal sources. Wohlgemuth u. Massone, Arch. f. Gynäk., 1911, xciv, p. 367, do likewise. Wolff, B., Arch. f. Gynäk., 1909, lxxxix, 177, on the other hand, believes the liquor amnii is purely a fœtal product.

[1] From the Pathological Laboratory of the College of Physicians and Surgeons, Columbia University, New York City. A Thesis for Fellowship in the American Gynecological Society, May, 1912.

Anatomical variations of the placenta. As a representative of the lowest type of placenta, that of the torpedo may be instanced. In this viviparous fish the fœtal structures are separated from the maternal by a layer of fluid.[1] A closer relationship is noted in the diffuse placenta of the pig, in which the epithelial covering of the uterus persists, and the placental villi are in part separated from the uterine mucosa by extravasation of blood and secretions of the uterus, in part are in direct contact with the uterine mucous membrane. In the placentæ of herbivora the major portion of the villi merely dip downward into the uterine glands, as in the preceding type, and more intimate fusion between fœtal and maternal structure is limited to the apices of the uterine rugæ (caruncles), where the uterine surface epithelium has disappeared. In rodents this fusion is still more accentuated by complete absorption of the uterine surface epithelium and the elaboration of a placental labyrinth, which consists of innumerable blood channels, within which the maternal blood comes into intimate contact with the covering of the fœtal villi. In primates and the human species the barrier between fœtal and maternal blood is still less developed. The villi may be said to project into large vascular channels, through which the mother's blood freely circulates. The roof of the placenta is formed by fœtal villi covered with syncytium, the floor mainly by fœtal cells which replace the endothelial lining of the maternal blood channels (Grosser [2]). In no species does a direct interchange of maternal and fœtal blood take place. In the lower forms material has to traverse not only the wall of the maternal vessel, but also the circumvascular connective tissue and uterine epithelium, pass through the intervening hiatus filled with extravasated material (uterine milk), and then penetrate the fœtal syncytium, connective tissue and vessel wall. In the higher forms, in which the villus is directly bathed by maternal blood, material for exchange need only penetrate the various layers of the villus until it reaches its central vessel.

Means by which exchange may be effected through the placenta. In the lower forms the nourishment needed by the embryo is absorbed from blood extravasations and uterine secretion. In the higher types nutrition is derived from the rapidly circulating blood. The mechanism by means of which this exchange is effected is but partly understood, and the present research deals with certain phases of this problem.

No direct means are at our disposal to analyze the intake and output of the fœtus, or to apply the methods usually employed in the study of metabolism as practiced on the adult. Variations in the metabolism of the mother during pregnancy are complicated by too many factors to be of assistance. Moreover, our chemical methods are as yet too crude to permit of analysis of the changes noted, for example the differences between that of the afferent blood of the uterine and ovarian arteries and of the efferent blood of the accompanying veins.[3]

Consequently investigators have been forced to approach the problem by other and less direct means. The absorption by the fœtus of substances—gases, fluids, and solids in solution—has been repeatedly demonstrated. The substances studied include many of those needed for the growth of the fœtus, also indifferent or harmful chemicals, dyestuffs, etc. In a like manner the reverse process, passage from fœtus to mother, has been conclusively proved.[4]

Before physiological and physical chemistry had made the surprising and rapid strides which have occurred during the last two decades, investigators focused their attention upon the determination of which substances traversed and which were excluded by the placental wall. To-day the form in which

[1] d'Erechia, F., Ztschr. f. Geburtsh. u. Gynäk., 1899, xl, 430. Studied torpedo occellata. The embryos of this fish reach full maturity in the oviduct. The maternal and fœtal part of the placenta are separated by a clear fluid. Respiration is by means of gills, the exchange taking place through the fluid. Nutrition is derived chiefly from the yolk sac.

[2] Grosser, O., Die Wege der fœtalen Ernährung innerhalb der Säugetierreiche. Sammlung anatomischer u. physiologische Vorträge u. Aufsätze, Heft 3, Jena, 1909. Also Vergleichende Anatomie und Entwicklungsgeschichte der Eihäute und der Placenta. Wien und Leipzig, 1909.

[3] Folin, O., u. Denis, W., Jour. Biol. Chemistry, 1912, xi, 87, in their paper, by as yet unpublished methods report experiments which foreshadow the possibility of determining such differences in the blood, and thus putting our knowledge upon a sound chemical basis.

[4] Kreidl, A., u. Mandl, L., Monatsschr. f. Geburtsh. u. Gynäk., 1904, xx, 919.

this exchange takes place and the means of transmission are of more immediate interest.

It was at first conceded that filtration sufficiently accounted for the necessary exchange. Later the phenomena were ascribed to osmosis. To-day selective secretion and a specific ferment activity of the placenta has gained more supporters.

Ferment activity of the placenta. The discovery of intestinal ferments, which were found to perform the chemical alterations which precede absorption of food, and the finding of similar or other ferments in all the chief organs of the body, have revolutionized physiological chemistry. It soon became apparent that all anabolic and catabolic processes in the body are intimately associated with ferment action, and it followed almost automatically that the ferment action of the placenta was subjected to close scrutiny.

General properties of ferments. Before proceeding with a description of the work done along these lines it may prove of service to give a few of the salient features relating to ferments and their mode of action.

As ferments have never been isolated or obtained in a pure condition we do not know their composition, and can classify them solely by means of their action upon a given medium (substrat). The action of ferments consists in accelerating a chemical reaction, without the ferments themselves taking part in the change. Ferments differ from inorganic accelerators (or catalyzers) such as sponge platinum, etc., by their instability, sensitiveness to heat, antiseptics, or poisons.

"*By means of ferments the plant or animal economy is able to perform at a low temperature changes which in the laboratory require high degrees of heat or the use of strong acids or alkalies.*"

The ferments found in the body may be divided into two groups, *extracellular* ferments, secreted by special glands, and *intracellular* ferments, which are found in every cell.[1] In order to study the latter, it is necessary to liberate the enzymes, either by the slow process of autolysis or to supplement this by the more rapid methods of mechanical cell disintegration (crushing and rubbing with sand, crushing in the Buchner press at 250–300 atmospheres pressure, etc.).

Ferments found in the placenta. The placenta has been thoroughly investigated in regard to its ferment contents. Representatives of every class of ferment have been reported. For the sake of brevity a table showing some of the ferments found in the placenta by investigators is appended (Table 1).

On critical examination of these reports two facts become strikingly apparent. In the first place, nearly all examinations were purely qualitative. In the second place, either no precautions were taken to remove the maternal or fœtal blood from the placenta, in which case the ferment content of the blood is added to that of the placenta, or the blood was removed by such crude methods as that of repeated washing after the placenta had been reduced to a pulp, in which case an undeterminable amount of liberated intracellular ferment is washed away. If human placenta is employed, and this was the material used in most investigations, coagulation takes place before the afterbirth is expelled, and no amount of perfusion through the umbilical vessels will remove all the fœtal blood. Even if the perfusion liquid returns clear, colorless fibrin, which has the property of adsorbing large quantities of ferment, will adhere within the smaller vessels. From previous work, in which I attempted to free human placentæ of their blood,[2] I am forced to conclude that it is impossible to make this organ blood-free by any method.

Based upon observations, of which a résumé is given in Table I, and upon certain other investigations which will be referred to, numerous authors have concluded that the placenta subserves a function similar to that of the liver (chiefly a metabolistic organ) and of the intestine (an absorptive organ). A few (notably Savaré, loc. cit.), more cautious, have stated that perhaps these ferments were used purely in the intracellular domestic economy of the placenta and had no general value or significance to the fœtus.

Functional tests. A few investigations, in which physiological methods were employed,

[1] Vernon, H. M., Intracellular Enzymes. London, 1908.

[2] Frank, R. T., Jour. of Exp. Research, 1907, ix, 263. Serological tests were used, but microscopically blood cells were likewise found.

TABLE I

FERMENTS OF PLACENTA

Author	Amylase	Lipase	Protease	Other Ferments	Method and Source of Placenta
MATHES [1]			Protease +		Human. Prolonged autolysis.
MERLETTI [2]			Protease +		Human.
BERGELL AND LIEPMANN [3]	Diastase + Glycolytic weak, Invertase —	Lipase —	Protease + (Pepton to tyrosin)		Human. Minced and washed.
HOFBAUER [4]		Esterase + (Salol)		Oxydase +	Perfused through vessels. Human.
BASSO [5]			Protease +		Human. Superficial washing.
CHARRIN ET GOUPIL [6]	Amylase +		Protease + (From blood)	Oxydase +	Human and dog's. Perfused through vessels.
SAVARÉ [7]	Amylase +	Esterase +	Fibrin coagulating + Desamydase + Ereptic + Glycoxalic splitting +	Direct and indirect Oxydase +	Human. Perfused through vessels.
NATTAN-LARRIER ET FICAI [8]	Amylase +	Esterase +	Protease —		Human and animal. Quantitative (?).
BERGELL AND FALK [9]			Protease + (heterolysis)		Human. Minced and washed.
LÖB AND HIGUCHI [10]	Diastase + Glycogenase + Inulase + Invertase + Lactase — Invertase —	Lipase —	Pepsin + Trypsin + Erepsin — Urease — Desamidase —	Katalase + Oxydase +	Human. Minced and washed.
HIGUCHI [11]		Esterase +		Selective glucoside splitting +	Human.
HIGUCHI [12]			Lab. + Fibrin ferment +		Human.
GRAEFENBERG [13]			(Up to 4th Month) Trypsin +		Human.

[1] Mathes, P., Zentralbl. f. Gynäk., 1901, xxv, 1385.
[2] Merletti, C., Atti de Acad. Sc. Med. e Nat., 1903, lxxvii, 213.
[3] Bergell, P., u. Liepmann, Münch. med. Woch., 1905, lvi, 2211.
[4] Hofbauer, J., Grundzüge einer Biologie der menschlichen Plazenta, Wien u. Leipzig, 1905.
[5] Basso, G. L., Arch. f. Gynäk., 1905, lxxvi, 162.
[6] Charrin et Goupil, Compt. rend. Acad. Sc., 1905, cxli, 301; ibid., 1906, cxlii, 595.
[7] Savaré, M., Beitr. z. chem. Physiol. u. Pathol., 1907, ix, 140.
[8] Nattan-Larrier et Ficai, Jour. de Physiol. et Pathol. gén., 1908, x, 60.
[9] Bergell, P., u. Falk, E., Münch. med. Woch., 1908, lv, 2217.
[10] Löb, W., u. Higuchi, S., Biochem. Ztschr., 1909, xxii, 316.
[11] Higuchi, S. Ibid., 1909, xvii, 21.
[12] Higuchi, S. Ibid., 1909, xxii, 337.
[13] Graefenberg, E., Ztschr. f. Geburtsh. u. Gynäk., 1910, lxv, 19.

are on record. Merletti (loc. cit.) perfused placentæ through the vessels of the cord, using a solution containing equal parts of glycogen and ammonium sulphate. He recovered the sulphate in unchanged amount, but the glycogen was diminished. The author, therefore, concludes that a glycogen-splitting ferment must be present. Charrin and Goupil (loc. cit.) performed similar experiments. Santi and Acconci [1] repeated this work with negative results. In all these experiments, as human placentæ were used, the sources of error previously mentioned obtain.

Chiage [2] performed a series of experiments under more normal conditions. He removed a portion of placenta and of the fœtal liver in bitches, then injected glucose into the mother, and at intervals took further specimens of both organs, which he tested for glycogen. He then found that both placental and liver glycogen increased after injection, but that as time elapsed the placenta lost part of its glycogen and the fœtal liver increased its store. These results, however, do not supply proof, as deduced from them by the author, that the placenta contains both an amylolytic and amylogenic (synthetic) ferment. They merely show that glycogen can pass through the placenta.

The ready passage of some substances, and

[1] Santi, E., et Acconci, G., La ginecologia, 1904, i, 252.
[2] Chiage, S. D., Ann. de Gynec. et d'Obstét., 1911, xxxviii.

the impermeable barrier interposed by the placenta to others, is well illustrated by table II, which contains a few of the important chemical compounds studied.

TABLE II

THE PASSAGE OF SUBSTANCES BETWEEN MOTHER AND FŒTUS

Substance		*Author*
Gases —		
Oxygen	+	Zweifel.
Carbon monoxide	+	Fehling.
Chloroform	+	Zweifel.
Ether	+	Nicloux.
Halogen Salts —		
Potassium iodide	+	Schauenstein u. Spaeth.
Potassium bromide	+	Porak.
Sodium chloride	+	Cohnstein u. Zuntz.
Strontium bromide	—	Plottier.
Salts Heavy Metals —		
Copper	+	Porak.
Lead	?	Paul.
Mercury	+	Porak, Cathelinau.
Colloidal silver	—	Hofbauer.
Benzol Compounds —		
Carbolic acid	+	Plottier.
Sodium benzoate	+	Gusserow.
Salicylic acid	+	Benicke.
Alkaloids —		
Morphine	+	Plottier.
Atropine	+	Preyer.
Quinine	+	Porak.
Curare	—	Wolter, Fehling.
Ergotin	—	Beatty, Wolter.
Hydrastinin	+	v. Bunge.
Glucoside —		
Phloridzin	+	Schaller.
Dyes, etc. —		
Analin	—	Wertheimer u. Meyer.
Adrenalin	—	
Alizerine	+	Flourens.
Methylene blue	+	Reusing.
Indigo	+	J. C. Mayer.
Indigo carmine	—	Zuntz.
Trypanblau	—	Goldmann (found in liquor).
Sudan III	+	Hofbauer.
Proteins —		
Peptone	—	Wertheimer u. Delzenne.
Egg albumin	—	Ascoli.
Methhæmoglobin	—	Wertheimer u. Meyer.
Miscellaneous —		
Bile	—	Kehrer.
Bile acids	—	Kehrer.
Antitoxin	+	Ehrlich.
Agglutinins	+	Jurewitsch.
Glucose	+	Cohnstein u. Zuntz.
Leech extract	—	Wertheimer u. Meyer.

NOTE.— Most of the references found in this table are taken from Kehrer: "Der plazentare Stoffaustausch in seiner physiologischen und pathologischen Bedeutung," Würzburger Abhandlungen aus dem Gesamtgebiet der prakt. Med., 1907, vii, 17; and from Nicloux: "Passages des Substances Chimiques de la Mère au Fœtus," L'Obstétrique, 1909, xiv, 840.

The selective action of the placenta as shown by these investigations (Table II) might be due to differences in osmotic pressure, to selective secretion (as found in the kidney), or to the decomposing and synthesizing action of placental ferments. It would carry us too far to enter into a detailed discussion and analysis of these data, as practically all the newer theories of physical and physiological chemistry are concerned (Lipoid theory, osmosis versus secretion, Verteilungsatz, etc.). As much of the subject as concerns us will be referred to later.

Activity of fœtus. Another complicating factor requiring to be considered is the independent activity of the fœtus, which in its blood and organs harbors, even at an early stage, practically all the ferments found in the mother. Numerous investigations bearing upon this point have been made. Of these, the ones shown in Table III, are most important.

It is, therefore, apparent that the fœtus can, and perhaps does, utilize and work up for its own use pabulum supplied by the mother, even if it is supplied in a form not exactly suited to the immediate needs of the embryo.

To recapitulate: The gap between mother and fœtus is bridged by the placenta. The foodstuffs carried to the placenta are contained in the blood. Certain substances are accepted, others rejected. The excretory products elaborated by the embryo also reach the maternal blood through the placenta. The presence of ferments, though suggestive, does not necessarily imply that these ferments perform the work; they may be present merely as an integral part of the placental cell, and the placenta may act purely as a delicately adjusted filter (using this term broadly to include osmosis, diffusion, and even selective secretion).

On the other hand the placenta may prove to be a complex organ of metabolism, which during its short term of existence fulfils functions similar to those ascribed to the liver, though differing in anatomical structure from this organ, in order to meet the different conditions imposed upon it.

Possible functions of the placenta. If the placenta acts mainly as an organ of exchange we are justified in comparing its function, roughly speaking, to that of the capillary endothelium or to that of the kidney [1]. It would then serve to remove, by selective

[1] Ascher, L., Der physiologische Stoffaustausch zwischen Blut und Geweben. Sammlung anatomischer und physiologischer Vortr. u. Aufsätze, 1909, Heft 5, Jena. The author reviews the evidence which shows that the endothelium has the power of contractility and is well supplied with nerve fibers. The capillary wall is permeable for all substances normally found in the blood, but varies for different substances in different regions. He negates the secretory activity of the endothelial cell, as championed by Haidenhein, and places the responsibility for passage outward or inward from the lumen chiefly upon the surrounding parenchyma cells. The selective power of the cells rests upon a purely physical basis, depending upon the distribution of a substance in two adjacent solvents according to a constant (division coefficient) — Law of Distribution (Verteilungsatz).

TABLE III

FERMENTS IN EMBRYOS

Author	Ferment	Present / Absent	Species: Size or Age
MENDEL AND LEAVENWORTH [1]	Autolytic	+	Liver of pig
COHNHEIM [2]	Invertase	+	Earliest digestive ferment, dogs, cats.
MENDEL [3]	Invertase Maltase Lactase	— + +	Absent in pig. Pig 50 mm. Pig 50 mm.
PLIMMER [4]	Lactase	—	None till 12 hours after birth.
STAUBER [5]	Diastase	+	Cattle embryo in pancreas, parotid, 230 mm.
LANGENDORFF [6]	Diastase	+	Pig pancreas 90 mm. Human absent.
MENDEL AND SAIKI [7]	Glycogenase	+	Pig liver, blood, muscle.
MENDEL AND LEAVENWORTH (loc. cit.) [8]	Lipase (esterase)	+	Early in pig liver and intestine.
LANGENDORFF (loc. cit.)	Pepsin Trypsin	+ +	Pig's stomach 135 mm.; human 4th month. Pig's pancreas 135 mm.; human 5th month.
IBRAHIM [9]	Pepsin and Trypsin Eropsin and Enterokinase	+ +	Human 4th month. Human 5th month.
JAEGGY [10]	Erepsin	+	Human intestine 5th month; pancreas negative.
VERNON (loc. cit.)	Erepsin	+	Guinea pig's kidney, liver, etc.
DURHAM [11]	Tyrosinase	+	Skin of rat, guinea pig, rabbit.
JONES AND AUSTRIAN [12]	Adenase	+	Pig's liver.
JACOBY [13]	Aldehydase	+	Pig 90 mm.
LOCHEMANN AND THIES [14]	Katalase	+	Rabbit, but less than in maternal.

[1] Mendel, L. B., and Leavenworth, C. S., Am. Jour. of Physiol., 1008, xxi, 69.
[2] Cohnheim, O., Nagel's Handbuch der Physiologie des Menschen, 1907, ii, 599.
[3] Mendel, L. B. Am. Jour. of Physiol., 1907, 8, xx, 81.
[4] Plimmer, R. H. A., Jour. of Physiol., 1906–7, xxxv, 20.
[5] Stauber, A., Pflüger's Arch. f. Physiol., 1906, cxiv, 619.
[6] Langendorff, O., Arch. f. Physiol., Physiologische Abt., 1879, 95.
[7] Mendel, L. B., and Saiki, T., Am. Jour. of Physiol., 1908, xxi, 64.
[8] Mendel, L. B., and Leavenworth, C. S., Ibid., 95.
[9] Ibrahim, J., Biochem. Ztschr., 1909, xxii, 24.
[10] Jaeggy, E., Zentralbl. f. Gynäk., 1907, xxxi, 1060.
[11] Durham, F. M., Proc. Roy. Soc., 1904–5, lxxiv, 310.
[12] Jones, W., and Austrian, C. R., Jour. Biol. Chem., 1907, iii, 227.
[13] Jacoby, M., Ztschr. f. physiol. Chem., 1901, xxxiii, 128.
[14] Lachemann, G., u. Thies, J., Biochem. Ztschr., 1910, xxv, 120.

action, certain substances from the circulating blood, essentially unchanged, and transmit them to the fœtal circulation. In the fœtus the nutritive substances would then undergo further metabolic changes as the result of purely fœtal processes.

On the other hand, it is conceivable that the placenta combines in its activity functions corresponding to those of the small intestine and liver. If this were the case, the nutritive substances contained in the blood would undergo an intermediate digestive process during their transit through the placenta and reach the fœtus in a "predigested state." For it is hardly conceivable that a complicated mechanism has been elaborated for the sole purpose of changing the foodstuffs circulating in the blood in order merely to facilitate their absorption through the placenta, and a reverse metamorphosis provided for (synthesis) to bring them back to their original chemical state when they reached the fœtal vessels. (Hofbauer, loc. cit.)

It is true that a somewhat analogous mechanism exists in the small intestine. The analogy is, however, more apparent than real, because the mucosa of the gut absorbs foreign ("artfremdes") protein, breaks this down into indifferent radicals ("Bausteine"—chiefly amino-acids) which are then resynthesized into products homologous to the organism. The placenta is supplied with foodstuffs which are already homologous and which therefore require no such molecular rearrangement.

It should prove of interest to study the placenta, from various aspects, after all demands upon its functional activity have been removed. This can be brought about experimentally, by causing the death of the fœtus, whereupon not only the call for nutritive substances ceases, but the presumable stimulus

exerted by the fœtal waste substances also stops.

Under these conditions we might expect changes in the ferment values to occur, although our knowledge of the effect of functional changes on ferments is almost nil.[1] In the various glands of the body it is impossible to produce similar conditions. For instance, ligation of the pancreatic duct causes an enormous, though transitory, increase of amylase, followed by gradual diminution far below the normal, in consequence of atrophy of the secreting cells.

To put glands which have no secretory duct out of function, it would be necessary to cut off their nutritive blood supply (even an Eck fistula would not produce the proper conditions).

Placenta after death of the fœtus. Anatomical studies (Merttens [2]) have shown that the placenta undergoes few morphological changes after death of the fœtus, remains well nourished for long periods of time, and may even continue to increase in size under these conditions. In most of the observed cases, however, fœtal death has probably been due to changes taking place primarily in the placenta. I have had the opportunity to study a human placenta in a case in which fœtal death was due to a tight knot of the cord.[3] This placenta was retained at least twenty-four hours after fœtal death, but showed no changes in its microscopic structure, though the fœtus had undergone maceration.

Aim of the investigation. The present investigation was undertaken *to determine whether any differences existed in the ferment content of the functionating as compared with that of the non-functionating placenta.* The technique devised by Zuntz (loc. cit.), and lately revived by Wohlgemuth and Massone (loc. cit.) (in their studies of the source of the amniotic fluid) was used. This technique permits of killing the fœtus in utero without injury to the placenta, and permits of direct comparison, in the same mother animal, of placentæ which are performing their function, and of placentæ whose nutrition is presumably not disturbed, but upon which no functional call is made. The former I shall speak of throughout, as "*functionating placentæ*," the latter as "*vegetative placentæ*." In addition, in five experiments placentæ were found the fœtus of which had either been entirely absorbed or had died at an early stage of development. These placentæ will be spoken of as "*old placentæ*."

PLAN OF EXPERIMENTS

1. It was first necessary to determine whether the ferment content of different functionating placentæ from the same mother animal was equal, weight for weight.

2. The effect of the partial or nearly complete removal of the maternal blood upon the ferment values was next studied, for if perfusion could be performed without disturbing the quantitative relations, the ferments of the maternal blood would then be eliminated, at least to a great degree.

3. Finally the effect upon the ferment values, of stopping the fœtal circulation and with it removing the functional demands normally made upon the placenta, was investigated.

Source of material. Animals which carry several young during pregnancy were chosen, in order to compare functionating with vegetative placentæ under identical conditions. Several different species were used (rabbits, guinea pigs, cats and one bitch) in order to exclude the possibility that individual species variations or differences in structural connection with the uterus (vide ante) might influence the results.

Ferments studied. Of the many possible ferments but three were investigated — amylase, lipase (esterase), and erepsin. They were chosen partly for reasons of expediency, as comparatively simple tests can be applied, partly because of their special significance.

Amylase, or starch hydrolyzing ferment, is a

[1] Very little is known about the relations of ferment and function. Vernon, loc. cit., p. 37, has attempted to correlate these factors by studying the ereptic power under varying functional conditions. He concludes that "given similar conditions the average ereptic value of a tissue may be roughly constant. . . Though the average amount of erepsin in a tissue is nearly constant, yet it varies very greatly with the functional activity of the tissue. It increases rapidly as the embryo develops; is moderately affected by diet in adult animals; is greater in the active than in the hibernating hedgehog; and decreases in disease."

[2] Merttens, J., Ztschr. f. Geburtsh. u. Gynäk., 1894, xxv.

[3] Frank, R. T., Am. Jour. of Obstet., 1907, lv, No. 6. This placenta shows no such changes microscopically as appear when a dead organ is subjected to autolysis for twenty-four hours (hæmatoxylin-eosin). Hofbauer, loc. cit., describes a placenta in which the prolapsed cord was torn across twenty-four hours before expulsion. This placenta also was fresh and unchanged.

representative of the important group of carbohydrate-splitting enzymes. It is present in all tissues which contain glycogen and also in the blood.[1]

Lipase (esterase) is supposed by many to be due chiefly to the blood contained in organs. It was, therefore, selected as an index of the amount of blood present and the quantity removed by perfusion.

Erepsin is the ferment which hydrolyzes peptone into lower products. It, of all enzymes, has been most thoroughly investigated in reference to changes in values, due to changes in function (Vernon, loc. cit.).

Standards of comparison. In each case the ferment content of the maternal blood serum was used as a standard. In most instances the uterine muscle was also used as a control. No direct comparison of ferment strengths obtained from different experiments was attempted, as even slight variations of time, temperature, concentration of solutions, etc., invalidate the use of such data.

TECHNIQUE, MATERIAL AND METHODS

Pregnant animals, the date of impregnation known, were anæsthetized with ether, and either bled to death from the carotid or, when mentioned in the protocols, bled until nearly exsanguinated, and then washed out through the jugular vein until the return flow was nearly colorless and the heart had ceased to beat. In animals whose vascular system was irrigated, one or more fœtal sacs were removed before the bleeding and irrigation was begun, in order to collect data on the amount of ferment accounted for by the maternal blood. The last wash-water obtained from the carotid artery was tested for its ferment strength in order to compare it with the full maternal blood.

To obtain "vegetative" placentæ, aseptic laparotomy was performed 12–48 hours before the animal was killed. The head of the fœtus to be killed was pressed against the uterine wall, a fine hypodermic needle introduced through the uterine wall into the cranial cavity of the fœtus and 0.5–1.0 ccm. of sterile olive oil forcibly injected. Injections with salt solution did not have the desired effect and sodium hydrate or sublimate solution, as used by Zuntz and Wohlgemuth and Massone, were not employed, as they could not prove indifferent to the ferments.

Material. The fœtal sacs were punctured, and whenever liquor amnii, uncontaminated by fœtal blood, could be obtained, it was tested for ferments. Small fœtuses were used entire. In large fœtuses individual organs were tested. The placentæ were freed from cord, decidua, and membranes. The uterine wall was used as a control, usually comparing the horn removed before and that removed after irrigation. The maternal blood was defibrinated and at once centrifuged, clear serum only being used in the tests. Several determinations with whole blood were also made. All solid material was weighed to milligrams, ground up thoroughly with quartz sand, and diluted with 0.9 per cent salt solution (usually 10 ccm. for 1 gram of wet material). (The same salt solution was used throughout the course of a given experiment for every dilution employed, in order that no variations in concentration might occur). The extracts were then placed in the ice box for two hours, and centrifuged for six minutes at the same speed. All figures are based upon one gram of wet material as the unit for solids, and one cubic centimeter for liquids.

METHOD OF FERMENT DETERMINATION

Amylase. Wohlgemuth's method,[2] which is based upon the property of starch to turn blue when iodine is added, but to remain colorless after a certain degree of digestion has occurred (change to achrodextrin) was used. In a series of test tubes (6–7) diminishing quantities of extract were placed. To each tube 5 ccm. of clear, freshly prepared 1 per cent solution of Kahlbaum's soluble starch was added. Enough salt solution to bring the contents of each tube to 6 ccm., and 0.2 ccm. of toluol to prevent putrefication, were added. The tubes were then incubated for from 12–19 hours at 38° C. When the readings were to be made each tube was diluted with ice water and one drop of $^1/_{12}$ normal iodine solution dropped in. The last tube in which no blue or pink color appeared showed the smallest quantity of extract capable of digesting 5 ccm. of starch to the achromic stage. After correcting for the dilution of the extract, values based upon the complete digestion of 1 cm. of 1 per cent starch were calculated. (When the starch solution is allowed to drop into the test tube without touching its wall, no disturbing color reactions occur, and the graded shades of blue to pink of the partly digested mixtures in the lower tubes of the series, also show close correspondence, thus greatly enhancing the accuracy of the method.) The quantities of extract used were part of a geometric series of 1.0–0.64–0.4–0.25–0.16–0.1–0.064–0.004.[3]

Lipase (Esterase). This test is based upon the property of lipase to split the esters of fatty acids, thus setting free the fatty acid with resulting increase of acidity. The amount of acid set free was determined by titrating with $^1/_{20}$ normal sodium hydrate, using phenolphthalein as indicator. Calculations were based upon 1 gm. of solid.

[1] Wohlgemuth, J., Biochem. Ztschr., 1909, xxi, 381.

[2] Wohlgemuth, J., Ibid., 1908, ix, 1.

[3] The modification recommended by Hawk, P. B., Arch. of Int. Med., 1911, viii, 552, was tried. By means of this method neutrality is maintained throughout incubation. As no differences were noted isotonic salt solution was used.

The tests were made as follows: 1 cm. of extract; 5 ccm. of salt solution; 0.3 ccm. of absolute ethyl butyrate and 0.2 ccm. of toluol were used for each experiment. A "blank" in which the extract was first boiled before adding the butyrate, etc., was used for each individual extract. The mixtures were then incubated for 12–18 hours and titrated. Readings were corrected by first subtracting the amount of acidity found in the blanks and then correcting for dilution.

Erepsin and alkaline protease. Considerable trouble was encountered in devising an applicable method. Fermi tubes,[1] Gross' casein method [2] and Vernon's colorimeter method [3] had to be discarded. Finally a modification of Vernon's method was devised, which gives accurate readings for the small values obtained.

The method is based upon the property of proteins of certain composition to give the biuret test (pink to blue color when added to an alkaline solution of copper sulphate). When digested to a certain stage the coloration does not occur (abiuret stage). The depth of color depends upon the amount of biuret-producing protein in the fluid. The tests were performed as follows: To 1 cm. of extract were added 5 ccm. of salt solution; 5 ccm. of 2.5 per cent solution of Witte's peptone, 0.1 ccm. of 0.5 per cent solution of sodium carbonate and 0.2 ccm. of toluol. A boiled "blank" similar to that used for lipase was prepared for each extract. The mixtures were incubated 24 hours. Then 0.3 ccm. of the incubated mixture was added to a tube containing 9 ccm. of 4 per cent sodium hydrate and 1 cm. of $^1/_{50}$ normal copper sulphate. The "blank" was treated in the same way. After 10 minutes, by which time the maximum color-change has been reached, the solutions are placed in the chambers of a Duboscq colorimeter. The blank is put at 20, 25 or 30 as the case may be, and the scale on the ferment side is moved up and down until the colors correspond. The mean of three readings is taken; the difference between standard (blank) and active ferment mixture determined, and figures corrected for dilution. Unless the ereptic activity is slight the colors cannot be made to correspond. This method appears accurate and is simple. [4]

Using these methods, 12 experiments were performed. Amylase determinations were made in all 12, lipase determined in 11, and erepsin in 5. In five animals the mother's vascular system was irrigated. In three animals vegetative placentæ were prepared by killing fœtuses in utero, and in five animals old placentæ were encountered. In three experiments functionating, vegetative, and old placentæ could be tested in the same animal. For details see summarized protocols.

RESULTS OF FERMENT DETERMINATIONS

1. Functionating, unperfused placentæ of the same animal were found to contain similar amounts of amylase (see Exp. I, II, V, IX) and nearly similar amounts of lipase (see Exp. II, VI, IX). The ereptic content was less constant.

2. Functionating perfused placentæ showed greater variations, proving that removal of maternal blood, even by means of the perfusion of the living animal, cannot be relied upon to give quantitative results.

3. Vegetative placentæ showed no variations from functionating placentæ, in some instances containing slightly greater, in others the same or slightly less, ferment (see Exp. IV, V, XI).

4. Old placentæ (not functionating for long periods, but containing large numbers of normal cells, as shown by their reaction to the ordinary stains, except in one case, where

[1] Fermi, C., Zentralbl. f. Bakteriologie, 1906, xvi, 176. At room temperature the extracts were too weak to attack the gelatin within reasonable limits of time.

[2] Gross, O., Arch. f. exp. Pathol., 1908, lviii, 157. Here the cloudiness of the organ extracts interfered with accurate readings.

[3] Vernon, H. M., Jour. of Physiol., 1904, xxx, 330. For large number of determinations the method is very time consuming. The method does not permit correction for the amount of protein contained in the different organ extracts, part of which is reduced to peptone during incubation, a not inconsiderable source of error, especially when dealing with weak enzymes.

[4] This modification permits of making 15–20 determinations in half an hour. A very small amount of alkali, 0.1 ccm. of 0.5 per cent sodium carbonate was added to the incubated extracts, sufficient only to counteract the acidity developed during autolysis. This low alkalinity serves to maintain the ereptic activity at a maximum and reduces the disturbing influence of other proteases (trypsin-like ferments) which act best in a more alkaline medium. The following experiment illustrates the accuracy of the method. A very weak solution of pancreatin was prepared, diminishing quantities were arranged in series, incubated for 15 minutes, and treated as above described.

Quantities.	Readings.	Reading Value.	Corrected Value.
1. 1.0 solution 1.0 solution boiled	21.5–22–21.9=21.8 20	1.8×1.0	1.8
2. 0.64 solution 0.64 solution boiled	21.3–21–21=21.1 20	1.1×1.5	1.65
3. 0.4 solution 0.4 solution boiled	30.7–30.7–30.83=30.73 30	0.7×2.5	1.75
4. 0.25 solution 0.25 solution boiled	25.5–25.2–25.5=25.4 25	0.4×4.0	1.6

Here an extract of which one cubic centimeter gave a difference of only 1.8 on the Duboscq was used, yet the values obtained show a maximum difference of only two divisions of the Vernier. When extracts 1 and 2 were compared with simple incubated peptone (corresponding to Vernon's method) the corrected values were 4.8 and 4.6, a much higher reading, accounted for by the protein contained in the pancreatic extract. The organ extracts used in the placental experiments contained much more protein and would, therefore, have greatly increased this error.

chiefly coagulated material remained) had approximately the same ferment strength as functionating and vegetative placentæ.

5. The amylase content of all placentæ, with exception of experiment V, was the same or less than that of the maternal blood. The lipase content of the maternal blood, however, was always less than that of the placenta and the ereptic content much less.

6. The uterus (either parts taken from the unimpregnated horn or distant from the placental site) contained almost as much ferment as the placentæ, although the amount of blood in the uterine extracts was much less than in the placental extracts, as could be noted in every instance by the relative amount of hæmoglobin present.

7. The fœtal blood or liquor always contained less amylase than the maternal blood; the lipase value usually less, though equal in two cases (Exp. VII–IX).

8. In the six rabbits examined, neither placentæ nor maternal blood showed any regular increase or decrease of ferment strength, corresponding to the progress of pregnancy (15th to 30th day).

CONCLUSIONS TO BE DRAWN FROM THE INVESTIGATION OF FERMENTS

1. A large part of the ferment found in the placenta is accounted for by the contained maternal and fœtal blood. The ferment values of the placenta approach those of the uterus approximately, but fall far below those of the liver.

2. Changes in function are not accompanied by any change in the ferment content sufficient to be demonstrated by the methods used.

3. Even small fœtuses contain an appreciable amount of ferment. The organs of large fœtuses have high ferment values, which sometimes exceed those of similar organs in the mother.

The result of the foregoing investigation of the placental ferments affords no support to the view that the placenta acts as an accessory organ of metabolism to the fœtus; on the other hand it supplies no conclusive proof to the contrary.

To some degree, the criticism is justified that the methods employed were not sufficiently delicate to record small variations — variations which might, nevertheless, suffice to satisfy the modest requirements of the fœtus; and that the study of other ferments, for example of the oxydases, might have given positive results. The same criticism applies, however, to a far greater degree to the sweeping theories and deductions drawn by various authors from work based upon similar methods without attempt at control (see Table I), and accepted more or less generally by physiologists and the medical profession.

In order to supplement and check the ferment investigation another method of study was pursued — that of "vital" staining. In contrast to the preceding this method is considered extremely delicate and reacts to minutest variations.

"Vital" staining. A number of dyestuffs have been discovered which, when injected during life, are avidly taken up by certain cells of the body. A clearly marked selective affinity between the dye and particular cells can be noted. Moreover, not the entire cell, but only definite granula within the protoplasm, accept the stain. At present the opinion prevails that these granula are intimately connected with the cellular metabolism (Ribbert [1]); that in consequence of pathological changes the granula diminish or disappear (Schlecht, Pari, Masuda [2]), and that in conditions of hyperfunction they increase in number. As the result of severe injury, some cells which ordinarily do not accept the stain have been found to stain diffusely, and under these conditions even the nucleus, which in a healthy cell is uncolored, may show some coloration.

Dyestuffs. Basic dyes which possess the

[1] Ribbert, H., Ztschr. f. allg. Pathol., 1904, iv, 201, showed that the injured cells in kidney infarcts stained diffusely after intravenous injection of lithioncarmin.

[2] Schlecht, H., Ziegler's Beitr. d. pathol. Anat., 1907, xl, 312, confirmed Ribbert's results. He adds that dead cells do not take up the dye. Pari, G. A., Frankfurter Ztschr. f. Pathol., 1910, iv, 1, produced different cell injuries (trauma, freezing, icterus, phosphorus poisoning, hydronephrosis, etc.) and noted that in response to slight injuries the granula disappeared; after severe disturbances diffuse staining occurred. In unilateral hydronephrosis the other kidney, which underwent compensatory hypertrophy, showed an increase of the granula. Masuda, N., Ztschr. f. exp. Pathol., 1911, ix, 250, a pupil of Ribbert, carried the work further. He studied various dyes and found trypanblau and lithioncarmin best. He used drugs, animal extracts, etc., to produce cellular lesions. He also concludes that vital staining supplies a method to study the cell function and enables us to recognize conditions of hyperactivity and degrees of injury varying from functional depression to cell death.

SUMMARIZED PROTOCOLS

DIATASE (1 cc. of 1% starch, 38°)

Exp.	Species	Day of Pregnancy	Mother: Maternal Blood	Mother: Uterus—Not Perfused	Mother: Uterus—Perfused	Mother: Maternal Liver	Placentæ: Functionating: Not Perfused	Placentæ: Functionating: Perfused	Placentæ: Vegetative: Not Perfused	Placentæ: Vegetative: Perfused	Placentæ: Old	Fœtus: Liquor—Live	Fœtus: Liquor—Dead	Fœtus: Fœtal Blood	Fœtus: Entire Fœtus	Fœtus: Fœtus Liver—Live	Fœtus: Fœtus Liver—Dead	Fœtus: Fœtus Kidney—Live	Fœtus: Fœtus Kidney—Dead	Exp. Details
I	Rab.	15	60				68 62 60													Animal bled to death. Placentæ then removed.
II	Rab.	16	62	60	35		60 60 60	 40				20			20 25					Before bleeding removed placentæ 1, 2 and 3; bled from carotid; perfused with saline, then removed placenta 4.
III	Rab.	19	75	45	37	150	75	57 45				10			12 32					Placenta 1 removed before bleeding; placenta 2 after bleeding, placenta 3 after perfusion.
IV	Rab.	24	65	45	40			 65	45	55	70					50	30			Fœtuses 1 and 2 killed 36 hours before. Last perfusion liquid from maternal vessels gave amylase value of 2.0
V	Rab.	28	60	110	50		150 150		175	150	150			150		120	100	120	100	Fœtuses 1 and 4 killed 17 hours before. Placenta 5 had dead fœtus of ¾ inch the other fœtuses being 5½ inches long. Last perfusion liquid gave amylase 20.0.
VI	Rab.	30	45	20		130	50 30				35			35 35		30 20		140		Placenta 3 was "old" with fœtus absorbed.
VII	G.P.	33	200	50		80	45					25			30					Maternal pancreas gave amylase 7500.
VIII	G. P.	36	156	37			125				135	10				75				Fœtus 1 alive and 2.5 ccm. long: fœtus 2 dead and ½ cm. long.
IX	G. P.	60	156				62 62 55 55							10 10						All fœtuses alive.
X	Cat	60	780	65	50		175	50 50 55				40 90				300 110			40	Placenta 1 removed before perfusing. Difference between placentæ 1 and 2 accounted for by amount of blood washed out (both placentæ, whole blood, and perfusion liquid dried to constant weight and calculations based upon this dry weight).
XI	Cat	60	250	40		90	65		55 70		65	16				105	105 35	65	40	Fœtuses 1 and 4 killed 24 hours before. Fœtus 3 was dead and "old," being 3¾ in. long, the others being 7½ inches.
XII	Bitch	?	78					10 10						50 50						Fœtuses all 12 ccm. long; perfused before removing placentæ.

SUMMARIZED PROTOCOLS (SERIES II)

Exp.	Species.	Duration of Pregnancy.	Amount Injected.	Injected Days after Operation.	Condition of Fœtuses at Autopsy: Live.	Condition of Fœtuses at Autopsy: Dead	Condition of Fœtuses at Autopsy: Absorbed.	Killed Days after operation.	Liquor.
1	G. Pig	25 days	20 cc.	Subc. 1 d.	2	1	..	2	Colorless
2	G. Pig	15 days	20 cc.	Subc. 1 d.	2	1	..	2½	Slightly blue
3	Rabbit	20 days	65 cc.	Subc. 1 d.	5	1	..	7	Blue
4	Rabbit	15 days	40 cc.	Subc. 2 d.	..	..	4	4	.....
5	Rabbit	15 days	20 cc.	Intrav. 2 d.	1	4	2	7	Blue
6	Rabbit	15 days	40 cc.	Subc. 1 d.	..	..	5	6	.....
7	Rabbit	18 days	30 cc.	Intrav. 2 d.	..	..	6	10	.....

SUMMARIZED PROTOCOLS

Exp.	Species	Day of Pregnancy	Mother				Placentæ					Fœtus							
							Functionating		Vegetative		Old								
			Maternal Blood	Uterus—Not Perfused	Uterus—Perfused	Maternal Liver	Not Perfused	Perfused	Not Perfused	Perfused		Liquor—Live	Liquor—Dead	Fœtal Blood	Entire Fœtus	Fœtus Liver—Live	Fœtus Liver—Dead	Fœtus Kidney—Live	Fœtus Kidney—Dead
LIPASE (ccm. of 1/20 Normal NaOH)																			
II	Rab.	16	1.9	5	5		2 3 2	3				0.5			3.4 2				
III	Rab.	19	1.5	2.2		11	1.5	0.5 1.5				0 0.7			0.3 1				
IV	Rab.	24	1.7	1.9	1.7			2.1	1.9	2	1.5	0.7	0.5			4.2	2.2		
V	Rab.	28	0.7	1.5	1.2		1.5 2.2		1.7	1.5	1			0.1		5.2	4.2	2	1
VI	Rab.	30	1.5			10.5	2.5 2.4									5.2 7		4	6
VII	G. P.	33	0.6			22	4					0.6			5				
VIII	G. P.	36	4.6	7.5			7				7.5	0.8				7.8			
IX	G. P.	60	1.6				4 4 3.5 3.5							1.1 1.6					
X	Cat	60	1	2	1		3	2 1.5 3.5				0				3.5 3.5			
XI	Cat	60	1.3	1.7		18	3.5		3 4.5		4	0.4				8.7	9.2 2.7	10.2	45
XII	Bitch	?	0.6					8 7.8											
EREPSIN (Colorimetric)																			
IV	Rab.	24	1.9		2.5				7.5	29	20								
V	Rab.	28		11			12 12		6.5	13.5	12						19	26	27
VI	Rab.	30	2	14		17	9 16				15					14 18		100	
X	Cat	60	1				37	18											
XI	Cat	60	0.2	15		61			30 28		23					40	14 12	82	20

property of dissolving lipoids, almost without exception stain intra vitam. Recently a number of acid dyes have been found which appear to possess the same qualities. In consequence, the *theory* of "vital" staining is even more unsettled than before, and it is considered inadvisable to enter into any discussion of this doubtful subject (Hoeber).[1]

The dye used in the present study was *trypanblau*. Trypanblau, as shown by Goldmann,[2] possesses the property of staining the granula of the liver endothelial cells, the Kupffer (star) cells of the liver, the epithelial cells of the kidney tubules and certain wandering connective tissue cells (pyrrol cells) throughout the body. Of especial interest is Goldmann's careful study of the behavior of the placenta to vital stains. As Goldmann's work is the only one, with the exception of a short paragraph by Schlecht (loc. cit.) and Hofbauer's [3] microchemical study which deals with the placenta, it will be discussed in some detail.

Goldmann (loc. cit.) found that in pregnant animals injected with trypanblau or similar dyes, the uterus early took on a deep coloration, the intensity increasing in proportion to the duration of pregnancy. The yolk entoderm cells, the placenta and the liquor amnii also became deep blue. *The fœtus, however, never showed coloration of any of its organs.* Microscopically he noted that in the uterus the so-called pyrrol (wandering connective tissue) cells alone accepted the stain. In the placenta the giant cells, which erode the maternal vessels, took up the color avidly, and many of the fœtal cells which bounded the maternal blood channels and in part constitute their wall, did likewise. The yolk entoderm cells also showed intensely stained granula. The author agrees with Haidenhein [4] that the acceptance of a vital stain is dependent upon the life activity of the cell and is consequently lost or changed by death or subsequent decomposition. The author's second paper [5] embraces a detailed account of the investigation of the glycogen, fat, iron, and hæmoglobin absorption, through the placenta, by means of refined microchemical methods. Although of importance, this paper requires no discussion in this connection.

As the result of these studies, it is known that certain cells normally show deeply stained granula; that these granula increase in size and number in conditions of hyperactivity and that they diminish or disappear when the cell is injured or its function disturbed.

The aim of the second portion of this investigation was to determine how death of the fœtus affected the "vital" staining properties of the placenta.

Material. A number of pregnant guinea pigs and rabbits were operated upon, by the same method used in the previous series, and after the lapse of 1–2 days injected subcutaneously or intravenously with a 1 per cent solution of trypanblau. On account of uncontrollable accidents but seven proved of use for the investigation. The impression seems warranted that the exhibition of the dyestuff is not completely indifferent to the organism, and that it hastens the absorption of the dead fœtuses and the disintegration of their placentæ.

[1] Hoeber, R., Biochem. Ztschr., 1909, xx, 56, gives a concise review of the theory of vital staining. He strongly favors Overton's views. For further details see Hoeber's "Physikalische Chemie der Zelle und der Gewebe," Leipzig, 1911.

[2] Goldmann, E. E., Beitr. z. klin. Chir. (v. Brun's), 1909, lxiv, 192. Supplement, used pyrrolblau, isanaminblau and trypanblau, all *acid* dyestuffs. His work bridges the gap between vital stains as such and the epoch-making work of Ehrlich, who uses dyes as chemotherapeutic agents.

[3] Hofbauer (loc. cit.) fed pregnant guinea pigs with fat stained with Sudan, but was unable to recover the stained fat in the fœtuses. His work with neutral rot was not "vital." Both this author and Goldmann draw too sweeping conclusions from results obtained solely by special staining.

[4] Haidenhein, M., Plasma und Zelle, Jena, 1907, ii, 416, gives an excellent outline of the literature to the year 1907. He accepts Ehrlich's view that drugs and dyes do not enter into synthetic combination with living protoplasm, but unite with the foodstuffs or other non-living material imprisoned within the cell. He defines a vital stain as one which is dependent more or less closely upon the activities of life, and which fails to act if the normal physiological activity of the plasma does not continue. But dead tissue may stain "vitally" if its interior milieu has not yet been altered.

[5] Goldmann, E. E., Beitr. s. klin. Chir., 1912, lxxviii, March, p. 1.

Fig. 1. Yolk entoderm membrane from functionating placenta; a, granula; b, vacuole filled with granula; c, nucleus of epithelial cell of papilla; d, connective tissue stroma; e, blood cells in capillary.

Fig. 2. Functionating placenta. Part of large blood vessel with wall formed by fœtal cells; a, vacuoles in protoplasm; b, large nuclei; c, red blood cells in vessel lumen; d, granula.

Fig. 3. Vegetative placenta. Part of large blood vessel with wall formed by fœtal cells; a, degenerating nucleus taking blue stain; b, slightly degenerated cell, nucleus stains faintly red, protoplasm diffusely blue; c, red blood cells in fœtal vessel lumen; d, red blood cells in small maternal vessel; e, fœtal cell, normal because in proximity to maternal vessel.

Fig. 4. Placental labyrinth of functionating placenta. Granula numerous; protoplasm stained with carmine.

Fig. 5. Placental labyrinth of "vegetative" placenta. Protoplasm diffusely stained with trypanblau; nuclei still normal.

Fig. 6. Tubule of *fœtal* kidney showing granules of trypanblau.

Fig. 7. Liver of same fœtus; a, endothelial cell lining capillary; b, red blood cells in capillary; c, liver parenchyma cell; d, star cell.

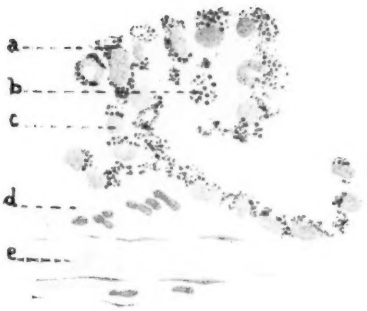

Fig. 1

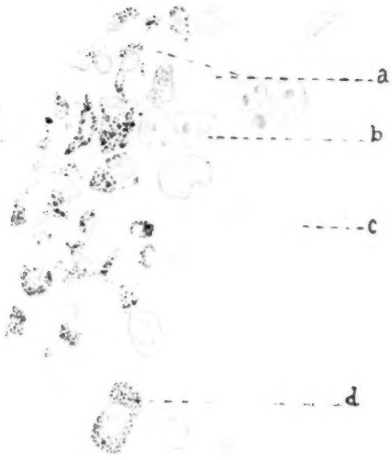

Fig. 2

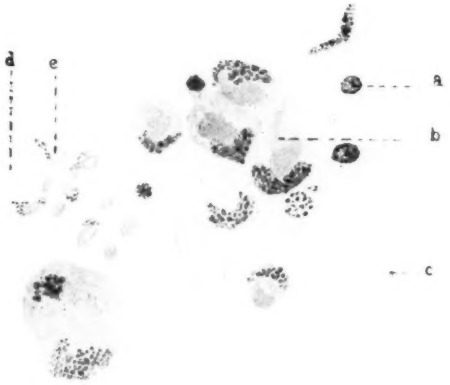

Fig. 3

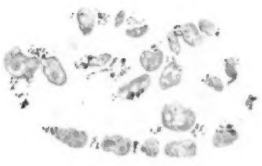

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Methods. The uterus was removed from the anæsthetized animal. In each case the mother's serum was deep blue. The fœtal sacs were at once opened, the color of the liquor amnii noted, and the condition of the fœtuses recorded.

All material was fixed in 10 per cent formalin solution. Part were cut as frozen sections, part rapidly embedded in paraffin (6 hours by the vacuum method). Sections were studied unstained, counterstained with alum-carmine, hæmatoxylin eosin and Sudan III.

RESULTS OF THE "VITAL" STAINING

1. Macroscopically the uterus was found to take the stain first; next in order was the yolk membrane and last the placenta.

2. Macroscopically no difference in the depth of staining could be noted in the placentæ of live and recently killed fœtuses. Those placentæ which were well on the way to absorption (old) accepted less color.

3. Microscopically the yolk entoderm cells of functionating, vegetative, and old placentæ could not be distinguished. All showed numerous and equally distributed granula. Fig. 1.

4. In the vegetative placentæ the granular structure was almost entirely lost. The stain was diffuse. The loss of granulæ occurred first in the placental labyrinth and next in the cell mantles surrounding the maternal blood vessels. Of similar types of cells those farthest removed from the maternal blood vessels showed degenerative changes first. Stained with hæmatoxylin eosin many of these placentæ appeared normal. Figs. 2, 3, 4 and 5.

5. The Sudan stain showed that in vegetative placentæ the fat accumulated chiefly in the cells about the intraplacental maternal blood vessels, the placental labyrinth containing less fat than that of functionating placentæ.

6. In Exp. III the kidneys of the five live fœtuses were macroscopically blue. Microscopically they showed the same selective distribution of granulæ as in the maternal kidney.[1] The livers also showed acceptance of the dye. Figs. 6 and 7. The cervical lymph glands of one of these fœtuses were also blue.

[1] Goldmann (loc. cit., 52) found the fœtal kidneys unstained. He therefore concluded that, as the liquor amnii is blue, the source of the fluid must be purely maternal. This view evidently cannot be accepted in the light of the findings in Exp. III.

Transverse section through rabbit's uterus at placental site. E, yolk entoderm; U, umbilical cord; G, region of giant cells.

GENERAL CONCLUSIONS

1. The placenta does not show any parallelism between its ferment values and its functional condition.

2. Changes in the minute structure of the placenta, as shown by "vital" staining, are dependent upon the nutrient supply of blood furnished by the mother.

3. The fœtal membranes possess a considerable degree of independence and maintain their function unchanged much longer than the placenta.

4. The fœtal membranes are more rapidly traversed by certain substances than is the placenta. Whether exchange effected by this route is of importance to the fœtal metabolism was not determined.

5. The evidence obtained in this investigation favors the view that the placenta is a passive organ for exchange, rather than an active organ of metabolism.

The final answer to the problem must, however, await the time when refinement in chemical methods will permit of reliable analysis of the difference in constitution between the maternal blood and that of the fœtal blood which enters and leaves the placenta.

NOTE.— The illustrations were drawn from sections obtained from Experiment III. The mother animal was injected with trypanblau. The blue is trypanblau injected during life. Normal nuclei and protoplasm accept the alum carmine counterstain. Leitz 1/12 oil immersion.

UNSUCCESSFUL SURGERY IN DISORDERS OF THE GALL-DUCTS TOGETHER WITH A CONSIDERATION OF NAUNYN'S CHOLANGIOLITIS [1]

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LOOKING through the last annual report of the first surgical division of Mt. Sinai Hospital, which I have the privilege to direct, I found that within this period, 57 patients with disorders of the biliary tract passed through our hands, on 53 of whom operations had been performed. Six, that is 11 per cent of these, presented instances of relapse demanding additional interference. The facts contained in these six histories suggested to me their presentation before your distinguished society for the sake of eliciting a discussion of the conditions leading to *recurrence after operations on the biliary tract.* Many bearings of the subject are still dark, some of the current conceptions offered by way of explanation are dubious and under discussion, hence they possess the interest of actuality.

In examining Kehr's statistics we find that he estimates the cures at 90 per cent.

In his comprehensive paper, E. M. Stanton[2] of Schenectady, N. Y., reviews Ochsner's series, and fixes the number of cures at 85 per cent in calculous cases, and at 46 per cent in noncalculous cases.

According to his report, only three times were overlooked stones found. This number seems very low, and may mean that only three times, were stones found in reoperated cases. Were there no overlooked stones present in those patients who did not submit to a second operation? Were there no stones in the cases declared to be noncalculous?

Another paper on the same subject, which I found most illuminating and remarkable for its philosophic grasp of the question, was written by B. B. Davis[3] of Omaha, and is worthy of attention by everyone interested in the matter.

Before entering upon the analysis of our subject, I wish to put this question: Do not we surgeons pay too much attention to one feature of the subject, namely, to the calculous phase of the process? This phase, to be sure, is most conspicuous, but does it not merely denote the terminal stages of a disorder of far greater and deeper significance? We diagnose calculus, we extract it, and there is an end of it. In removing a calculus, have we also removed the disease that caused the formation of the calculus, or have we merely eliminated a conspicuous, and certainly, the most troublesome symptom of the malady?

It is my object to direct your attention to this wider and more comprehensive view of the subject. There is nothing I would more earnestly recommend to my surgical confrères than a careful study of the masterly address delivered before the Leyden Society of Berlin, at the October meeting of last year, by that veteran investigator of the disorders of the liver and bile passages, Professor Naunyn. It embodies the ripe results of lifelong research and experience.[4] Permit me to present a brief synopsis of its most important features. By cholangitis, is meant disease of the entire system of bile passages, large and small, including the gall-bladder. The essential factor of the disorder is infection of the bile in the biliary passages, and this alone is sufficient to explain all of its manifestations. A cholangeitis can reach its acme as a typical, extremely dangerous disease, without becoming purulent, and without necessarily showing marked changes in the walls of the bile passages, just as experimental infection of the bile ducts by colon bacilli will kill the animals without the development of such changes. But this is a rare occurrence. Ordinarily, progress is much slower, and the primary onset of the infection rarely lethal. In most instances, the secondary effects of the infec-

[2] Jour. A. M. A., August 5, 1911.
[3] Jour. A. M. A., August 5, 1911.
[4] Naunyn, Cholangeitis, Deutsche med. Wchnsch., No. 44, 1911.

[1] Read before the Chicago Surgical Society, April 5, 1912. (See discussion, p. 627.)

tious agent upon the mucous lining have ample time to develop. Such are catarrhal and suppurative inflammation and ulceration, then hæmorrhage, circumscribed hepatic necrosis, and liver abscess, which are all, in general, the results of infection of the bile. The extension to the liver tissue issues from lesions of the smallest bile passages. The primary factor is the presence of micro-organisms in the bile, most commonly bacterium coli, which is ordinarily present in the duodenal portion of the common duct of healthy individuals. Naunyn calls this *normal bacterichолia*. As long as the stream of bile suffers no obstruction to its passage, this organism remains harmless, because its accumulation is kept down by constant flushing and removal into the gut. Whenever stagnation occurs for a while, a dangerous accumulation of the bacilli takes place, and this leads to *bacterial infection* of the bile. It is not necessary that the bile stream should be completely interrupted; any degree of stagnation may be sufficient. As the gall-bladder is not a duct, but a receptacle in which stagnation is practically a constant condition, this part of the biliary tract is the starting point and most frequent seat of bile infection. The vast autoptic experience gained within the last twenty years in the surgical treatment of cholelithiasis has taught us, that the colon bacillus is chief among the infecting organisms in cholangeitis. This enters the bile passages from the gut, and therefore infection from it is enterogenous. On the other hand the best example of hæmatogenous cholangeitis is the infection of the bile in typhoid fever. It is well known that the typhoid bacilli may thrive in the bile for years without causing any trouble to their host, who, while perfectly well himself, may be a dangerous typhoid carrier and disseminator. Occasionally, however, the typhoid bacillus causes serious trouble, especially where a secondary is added to the primary infection. The important part played by the infection of the bile in the formation of calculi is well known, and the maintenance and aggravation of cholangeitis by the presence of gall-stones is a fact so well established as not to require more than passing mention.

Naunyn's views regarding the formation of gall-stones have received important additions and corrections, for Aschoff and Bacmeister's investigations have shown that calculi may and do form in perfectly sterile bile. Aschoff found that an excess of cholesterin is regularly present in the bile of pregnant women. He considers this circumstance, together with the stagnation of the bile caused by displacements of the viscera due to the enlarged uterus, as main factors of the frequency of cholelithiasis in women who have borne children.

Formerly, attacks of paroxysmal pain, caused by impaction of calculi, were considered to be the typical feature of gall-stone disease. Cholangeitis was looked upon as an accidental, dangerous, but rare complication of stone impaction.

Naunyn's conception reverses this view. Cholangeitis is the fundamental factor, the formation of stones, a secondary and accidental complication. Pain, fever, icterus, swelling of the liver and gall-bladder, are not due to stone impaction alone; this is proven by their occurrence in noncalculous cholangeitis, as revealed both on the operating table and in the post-mortem room. Cholangeitis is the essential cause of all these manifestations. The view, that icterus in cholelithiasis is always due to obturation of the common duct by calculus, must also undergo radical revision, if not complete reversal. We have extracted stones of large size from the common duct in cases where icterus had never occurred except in the attack preceding operation; although the painful malady, chiefly characterized by gastric symptoms, had existed for several years. However, it should by no means be so understood that actual obturation will not cause icterus. Of course it will. We know that a very small stone, temporarily impacted in the ampulla of Vater during its passage into the gut may precipitate an attack of febrile icterus. This, however, is not so much the effect of the actual obstruction and backing up of the bile, as of the increased intensity of the infection, caused by the stoppage of the outflow and immediately responded to by an augmentation of swelling of the lining of the entire tract. The duration of obstruction may be very short, and the

expulsion of the stone may be manifested by a sudden cessation of colic; but the icterus and fever do not disappear for several days, perhaps even a week. This shows that besides the stone, some other factor must exist which causes and maintains icterus. Long continued, absolute obturation of the papilla also occurs, but is rather rare. It is the cause of a *chronic, progressive form of febrile or afebrile jaundice*, similar to that which is peculiar to intrinsic neoplasm. We shall see, that a large stone, actually impacted in the ampulla, permitted the free discharge of bile into the gut for two years, during which period gastric symptoms predominated, and only two very mild attacks of jaundice were observed. The presence of jaundice, when there are no calculi in the hepatic and common ducts or when they are confined to the gall-bladder and cystic dust alone; and, inversely, the absence of icterus where the common duct is occupied by a large stone, represent paradoxes which remain unexplained by the theory of calculous obturation, a theory so attractively proposed by your lamented member, Fenger.

Then there must be some other factor which is more constant than calculus and which is invariably present whenever febrile jaundice appears, with or without calculus, from any cause whatever. This factor is undoubtedly the infectious inflammatory œdema of the mucous lining of the bile tract, a swelling which extends to the finest ramifications of the biliary ducts, channels of a slenderness far exceeding that of the blood capillaries (Kupffer, confirmed by Pfeiffer). We need not assume the presence of problematic mucobiliary thrombi to explain jaundice; Naunyn's *cholangiolitis*, that is, the inflammatory swelling of the basal membrane and epithelial layer of the smallest bile ducts, being perfectly adequate to obliterate their lumina.

We find the picture of a typical, severe, infectious cholangeitis identical with that of an acute gall-stone attack. On the other hand, typical forms of cholelithiasis are extremely numerous; many of these never reach the surgeon. In them, sometimes the jaundice, sometimes the fever, predominates. Some even run a course without fever and jaundice, showing only a severe grade of anæmia and cachexia.

Cholangeitis is not a rare complication of acute infectious disease. Staphylococci, typhoid, cholera and pest bacilli thrive excellently in the bile passages, while the pneumococcus does not do as well.

For the term "catarrhal-jaundice" Naunyn proposed the unconditional substitution of the more precise expression, "primary infectious cholangeitis." This disorder may be due to retardation of the biliary flow through external compression by tumors or cicatrices, and through intrinsic causes, such as neoplasms of the bile passages, or circular cicatricial stenosis.

Naunyn is even inclined to consider the febrile forms of syphilitic hepatitis, both early and late, as a specific cholangeitis, and mentions that this view was expressed more than twenty-five years ago by a French author, whose views seem to be substantiated by recent investigation.

Assuming that Naunyn's revolutionary views find general acceptance, is it not rational to conclude that the remedy suggested by him, that is, the surgical drainage of the biliary tract, must also be accepted?

We can admit, without committing ourselves absolutely to the standpoint of Naunyn, that the clinical symptoms of infectious cholangeitis cannot be differentiated from those of calculous biliary disease. Stones may be present without biliary colic, and biliary colic often appears without any calculi. Calculi aggravate the symptoms, but the intrinsic and essential thing is the *cholangeitis, which often exists before stones are formed, and may continue after their removal.*

Let us now revert to the original subject of this study, to the causes of failure to bring about permanent cures in biliary surgery. The study of Naunyn's teachings will make us view the subject from a higher, far more comprehensive standpoint than that which we have heretofore been accustomed to hold. We shall learn not only to consider the gross

[1] The question may be asked: "Why is it then, that icterus and cholangeitis disappear after extraction of the calculus from the common or hepatic ducts?" The answer is: "They do not disappear always, nor at once, even when most effective measures are taken to insure external drainage. We have seen fever, icterus and swelling of the liver persist for four weeks after the stone had been extracted."

mechanical factors, such as stones, tumors, strictures, etc., but also to take into serious account the intrinsic morbid changes which affect the mucous lining, the connective tissue and unstriped muscle of the bile ducts. We shall not be content merely to find and remove stones, strictures, kinks and tumors interfering with the flow of the bile, but shall also endeavor to remedy surgically the infection of the mucous lining of the gall passages, in the same manner as we treat affections of other canals lined with mucous membrane.

Everything which relatively or absolutely obstructs the expulsion of bile will cause persistence of cholangeitis and of biliary disturbances.

Direct external pressure from adhesions, from the enlarged head of the pancreas, from other tumors or angulation by adhesions, prevent lasting relief and demand renewed intervention. A good example of occlusion by post-operative angulation of the common duct is presented in the following case:

CASE 1. Hospital Record. 1910–1911 (not yet paged). *Synopsis.* Acute cholecystitis and cholelithiasis; cholecystectomy, choledochotomy and drainage of hepatic duct; persistent biliary fistula due to angulation of common duct from adhesions, defect of common duct; division of adhesions, plastic closure of common duct. Cure.

Jennie G., 26 years of age. Russian, married. For past few years gastric symptoms following meals, not relieved by bicarbonate of soda. Never jaundiced, bowels regular. Had many attacks during past eleven months, each lasting seven to ten days. Last attack four weeks ago. Present attack since a week; epigastric pain, nausea and vomiting, fever and chilly sensations. Pains radiating to right shoulder. No jaundice until yesterday.

On admission, October 18, 1911. Thoracic organs sound. Slight icterus. Liver: Bulging of right lateral chest wall, no external œdema; marked tenderness on lateral compression; normal dimensions by percussion. In right hypochondrium a palpable mass, hard and tender. Upper segment of rectus rigid. T. 100.8° F., p. 90. Urine: Faint trace of bile.

October 21st. *Cholecystectomy and drainage of hepatic duct.* Gall-bladder much distended: 6 oz. of sero sanguinolent bilious fluid with some mucus, aspirated. Gall-bladder ablated, it contained one stone. Another stone felt in stump of cystic duct, was extracted. Common duct located by aspiration, then opened and through aperture tube passed into hepatic duct. Probe passed easily through papilla into duodenum. October 23d. Flow of bile through tube stopped spontaneously, bile escaping alongside of it; tube withdrawn. Stool well colored. November 23d. Discharged at her own request with biliary fistula. December 1, 1911; readmitted. Profuse biliary discharge, clay-colored stools. December 5th. Tamponing of fistula with tupelo tent. Immediate rise of temperature and typical biliary colic, T. 104.6, jaundice. Evident obstruction of common duct. December 16th. Easy exposure of common duct, division of adhesions, which were causing a sharp-angled kink of the common duct, the angle pointing upward; restoration of normal axis of canal. A small defect in the anterior wall of the common duct repaired by inversion; four transverse silk sutures. Omentum anchored over suture line. Drainage by packing to suture line. December 26th. No bile escaped since operation, stools became colored, jaundice disappeared. January 7, 1912. Discharged cured.

Epicrisis. The ease with which the common duct was exposed is to be noted.

Among intrinsic causes of relapse, stricture of the common duct must first be mentioned. When the stricture is situated in visible parts of the duct, it may easily be recognized, but when hidden by the duodenum or pancreas, neither palpation of the interior of the duct, nor probing, will insure its detection. Fortunately it is of rare occurrence and has never come within my own observation.

The leaving behind of undetected stones in the cystic, hepatic, and common ducts is another cause of relapse. External palpation of the cystic and common ducts is a most untrustworthy test of the absence of calculi, and even a careful internal search by finger tip and probe, may leave behind small concrements undetected. Here is an instructive example. In this case, the displacement of a good sized calculus (1 cm. wide, 2 cm. long) from the common, into a secondary branch of the hepatic duct, occurred, as it were, under our eyes during external palpation of the dilated common duct. The stone was felt by me in the duodenal end of the dilated common duct. The house-surgeon's request to palpate having been granted, I proceeded to open and explore the interior of the duct. The stone was gone. After considerable search it was found impacted in that branch of the hepatic duct which communicated with the right lobe of the liver. The mechanics of this dislodgment may be explained as follows: Compression of the distended duct necessarily

means displacement of a considerable volume of bile to the right and to the left of the compressing finger, causing an additional degree of distention of the walls of the ducts except at the actual point of compression. The displaced liquid thus being set in motion, generates two currents, one to each side of the compressed segment. If the stone happens to slip out from under the pressing finger simultaneously with the displacement of the bile, the fluid will carry the stone, a mass of cholesterin of very low specific gravity, hence of great lability, either towards the papilla, which is of no significance, or, what is very serious, into the overdilated hepatic duct or its branches. In other words, an impulse is imparted by the finger not only to the bile, but also to the slipping stone, which is thus launched with an added impetus into the hepatic duct at a moment when the latter and its branches are dilated *ad maximum*. As soon as the finger is removed, a return wave will start from each side towards the place of temporary compression. The plus of overdistention will become less, the walls of the hepatic duct will collapse to a degree below the mean of tension, the stone may be caught and retained. If this occurred to a large calculus in my case, how much easier may it happen to smaller ones?

CASE 2. Hospital Record, 1910–1911, p. 892. *Synopsis.* Cholecystectomy in 1905. Cure. Relapse of biliary trouble two years later. Repeated attacks with jaundice at long intervals. Choledochotomy, escape of stone into hepatic duct. Hepaticotomy and drainage of common duct. Cure.

Rebecca R.. 42 years of age. Austrian. Admitted February 7, 1911. After suffering from biliary colics for several years, gall-bladder was removed by me in 1905. Several stones withdrawn from pockets of cystic duct. Palpation of common duct was negative. Was well for two years after operation, then old trouble returned with attacks at shortening intervals. February 11th. Choledochotomy. Very easy exposure on account of entire absence of tight adhesions. During palpation of stone in common duct before incision, stone slipped up and became transversely lodged beyond bifurcation in a branch of the hepatic duct. After the emptying of bile it was grasped by the collapsed walls of the duct and could not be dislodged by any form of manipulation. The tip of the index finger could just touch it. Incision through hepatic parenchyma down upon the stone, was followed by its extraction and suture of the liver. Drainage with three tubes, one in each branch of the hepatic duct. March 3d, afebrile; biliary discharge profuse and very purulent. Irrigation twice daily. March 14th. No jaundice. Tubes removed as bile was limpid. March 17th, discharged cured.

Epicrisis. The accident observed in this case may be the paradigm of similar occurrences caused by palpation of a distended common duct. An evident distention of the duct should be first relieved by incision, the rush of the escaping bile will then be apt to carry all movable stones towards the vent thus opened, or at any rate prevent their backward escape into the hepatic duct or its branches. Palpation of the ducts freed from their liquid contents will be more effective than palpation of the distended channels. I am much inclined to the belief that premature palpation is often responsible for the unnoticed backing of smaller stones into the hepatic duct, which, remaining there, cause later relapses of obstructive trouble in the common duct. Easy exposure of the common duct was also notable in this case.

There is every reason to assume that, in the following case, stones must have been left in the hepatic duct at the time of the first operation. This consisted in removal of the gall-bladder and extraction of stones from the common and hepatic ducts. Relapse came on six weeks after the operation, when the wound was entirely closed.

CASE 3. Hospital Record, 1910–1911, p. 889. *Synopsis.* Cholecystectomy, choledochotomy for removal of stones from common and hepatic ducts; recurrence four years later; renewed choledochotomy and extraction of stones from common and hepatic ducts. Cure.

Rebecca Z., 53 years of age. Austrian, housewife. Admitted October 9, 1910. Four years ago at Mt. Sinai Hospital, the gall-bladder had been removed and stones had been extracted from the common and hepatic ducts. For six weeks after leaving hospital, felt well, then one of the old biliary attacks returned with pain radiating to right shoulder. Attack followed by transient jaundice. Repetition of attack every four to five weeks. Recently attacks more frequent, jaundice persistent, though of varying intensity. October 20th. Operation. Very easy exposure of enormously dilated common duct and extraction of a plum-sized stone; extraction of two stones from hepatic duct, in which they were felt by internal palpation. Drainage of

two branches of hepatic duct. Bile very turbid. Irrigation of ducts twice daily. November 25th. Drainage discontinued, as jaundice and clay colored stools had ceased. Temperature normal since November 21st. Discharged cured, December 14th.

Epicrisis. Note again the easy exposure of common duct in this case and the long continued cholangeitis in spite of good drainage and frequent, methodical irrigation.

In the following case I am also inclined to assume that the stone found in the common duct almost two years after cholecystectomy (done by myself) must have existed at the time of the first operation. The size and cylindrical shape of the calculus preclude the idea of recent formation.

CASE 4. Hospital Record, 1910–1911, p. 895. *Synopsis.* Cholecystectomy. Relapse two years later. Choledochotomy and extraction of stone. Cure.

Hannah K., 46 years of age. Russian, housewife. Admitted February 15, 1911. Two years ago had gall-bladder removed for calculous trouble. Then felt well until six weeks ago, when paroxysmal attacks of pain in right hypochondrium set in with chills, fever, vomiting, and radiation of pain to right shoulder. Jaundice marked, stools acholic. Liver enlarged, edge to be felt three fingers below costal border, markedly tender. Temperature fell from 103.6° F. to 100° F. after attack observed at time of admission. February 16th. Choledochotomy. Excision of old scar. The exposure of the common duct was somewhat difficult on account of the situation of the stomach and pylorus, which reached unusually far over to the right side. Most of the adhesions, however, were separable by blunt dissection. The head of the pancreas was enlarged and hard. Hepatic artery and portal vein were beautifully exposed to view. Common duct markedly distended. Incision of choledochus and extraction of a large cylindrical stone, 2 inches by ¾ of an inch, rough above and facetted at its distal base. As digital exploration proved absence of the stone which had caused the facetting, I concluded that it must have passed into the gut. On February 19th the stools became colored. The entire course of convalescence was afebrile. Up to February 26th, drainage and daily irrigations were employed. As bile had then become limpid, they were discontinued. March 7th. Rather free hæmorrhage from wound; controlled by packing. March 13th. Biliary discharge ceased. March 19th, discharged cured.

Epicrisis. Here also the ease of exposure of the common duct is to be noted.

I now present another history in which failure to ascertain the presence of a common duct stone at the time when the gall-bladder was removed for empyæma, made a secondary choledochotomy necessary.

CASE 5. Hospital Record, 1910–1911, p. 886. *Synopsis.* Empyæma of gall-bladder. Cholecystectomy; recurrent pain; choledochotomy, removal of common duct stones. Drainage of hepatic duct. Cure.

Lena H., 38 years of age. Austrian, housewife. Admitted October 24, 1911. Three and a half months ago, after curettage of uterus, developed pain in right hypochondrium, with fever, chills and vomiting. No jaundice. Gall-bladder emptied of pus and drained at another hospital. Nine weeks later jaundice, which since then steadily increased, with clay-colored stools. Lost 25 pounds. A fresh scar in right hypochondrium. October 26th, scar excised. Extensive adhesions between lower surface of liver, duodenum, stomach and transverse colon were easily separated, mostly by blunt dissection, in which the liver was the guide. Gall-bladder absent. Pylorus drawn far over to the right. At bottom of this artificial cavity, entirely separate from general peritoneal cavity, lay the dilated common duct. Its exposure had been easy. Four stones withdrawn from common duct and one from right branch of hepatic. Drainage of both branches of hepatic. Continued drainage and irrigation. November 7th, temperature normal and jaundice subsided. Discharged cured November 17, 1910.

You may have observed that in all the foregoing cases the secondary exposure of the choledochus was extremely easy. Yet in all of them the gall-bladder had been removed at a previous operation. And it may be added that, in my experience, this easy secondary exposure represents the rule rather than the exception. It was, and is still believed by some, that following removal of the gall-bladder at a previous operation, exposure and identification of the choledochus is extremely difficult and tedious. It is assumed that the gall-bladder serves as a ready guide to the deeper structures. This belief has been made a justification for preserving permanently damaged gall-bladders. I am convinced, however, that this line of argument is unsound. Obstruction of the common duct is rarely the cause of troublesome adhesions, while in the vast majority of cases, the presence of an infected, and often contracted, gall-bladder will produce close, extensive and very troublesome adhesions, which do not yield to blunt dissection, and require the perilous use of sharp-edged instruments.

Case 6 is presented as a type illustrating this circumstance.

CASE 6. Hospital Record, 1911–1912 (not yet paged). *Synopsis.* Mucobiliary fistula after cholecystotomy done three years ago. Cholecystectomy; drainage; tachycardiac attack. Cure.

Lena I., 52 years of age. Russian, housewife. Admitted October 31, 1911. Three years ago at another hospital the gall-bladder was drained after the removal of calculi. Felt well until five months ago, when local pain, fever, and vomiting set in and were followed by reopening of the scar, and the escape of pus and bile. Discharge since then had become alternatingly biliary and mucous, had no jaundice. No calculi felt by probing. General condition good. Pulse 86, regular, no cardiac murmurs present. Temperature 98.4° F. November 2d, cholecystectomy. Under ether anæsthesia the patient's condition repeatedly became alarming, both on account of shallowness of breathing, and feebleness and rapidity of the pulse, so that several interruptions of operation had to be made. Excision of scar and opening of peritoneal cavity at its lower angle, from here relations explored by palpation. Slow, careful dissection of scar and its cordlike conformation containing the sinus, which led to a small, hard mass, evidently a shrunken gall-bladder. Most of the dissection had to be done by cutting. The liver above and the transverse colon below served as guides. After anatomical relations had been cleared up, separation of the mass from the liver, and exposure of the cystic and common ducts followed more easily. Ligation of cystic duct near its entry into common duct; ablation of external scar, sinus walls, gall-bladder and cystic duct *en bloc*. November 3d. Precordial distress with the pulse estimated at 208 beats per minute, respirations 36, set in at 7 P. M., 27 hours after completion of the operation. This condition persisted until midnight. From then on a gradual decline of the tachycardia. By 7 the next morning, pulse was down to 96, the respiration to 24. Throughout, the pulse had been regular and of good tension. November 20th, phlebitis of left saphenous vein. From then on uninterrupted recovery. Discharged cured December 13, 1911.

Specimen: a small stone lodged in a pocket of the cystic duct, separated by strictures both from cavity of gall-bladder and from common duct.

Epicrisis. Suppuration in the bladder is the main cause of the formation of dense and extensive scars.

Regarding the indications for the removal of the gall-bladder, this much can be said: It is generally accepted that the diseased organ should always be extirpated. But in determining whether in a given case the gall-bladder is permanently damaged or not, great divergences of opinion will occur. My personal view of the matter is, that except in the most unquestionable cases, the benefit of the doubt should incline the surgeon's decision toward cholecystectomy. It is not necessary to bring forward the teleological theory of the rudimentary nature of the gall-bladder, its absence in most of the herbivora and the curious variations as to its presence or absence in the carnivora—for instance, that the two-toed sloth has a gall-bladder, while the three-toed sloth has none. The preservation of a gall-bladder, once the seat of an intense inflammation, merely because it may be of use, as nature would not otherwise have provided for it, is an argument tending towards scholasticism. The principal use of a damaged gall-bladder is that of a tractor to aid us in exposing the common duct. Having served this purpose it ought to be removed.

The preservation of an apparently normal gall-bladder filled with a large number of small stones, may also be of questionable value, as one cannot ever be sure of having removed every stone, especially from the tortuous cystic duct. On the other hand, where only one, or a few, large stones are encountered in a healthy-looking bladder, this organ may safely be retained.

The criteria for removal are: the presence of many adhesions, sure indications of previous severe inflammation, adhesions denote the loss of contractility, that is, the loss of function; then, gross evidence of actual inflammation in the mucous membrane, such as ulcer or cicatrix; finally, ulcer or stricture of the cystic duct.

However, the most important and most common cause of the recurrence of biliary colic and biliary fever, is failure to counteract, by effective, adequately extended, direct drainage, the various degrees of the ever-present cholangeitis.

Setting aside further consideration of the necessity for clearing out stones, dividing adhesions, dilating strictures, removing obstructing, intrinsic, and extrinsic tumors, let us now examine the question: Are there no other causes than these just enumerated, which may relatively or absolutely impede the flow of bile in and from the gall-ducts?

By this question we approach that large division of biliary obstructions which do not depend upon the presence of any of the grossly mechanical causes heretofore mentioned. They go under the name of non-calculous hepatic fever, non-calculous or idiopathic infectious cholangeitis, the surgical treatment of which has so far yielded much worse results than that of the calculous forms. Stanton's statistics give 46 per cent of cures, 54 per cent of failures.

Though chronic pancreatitis is undoubtedly one of the extrinsic factors causing retardation of the biliary stream, yet, as long as the question remains unsettled, which one of the two phenomena, biliary stagnation or pancreatic swelling, is primary, I prefer to consider this symptom complex as belonging to the group of idiopathic cholangeitis rather than to that due to gross obstruction.

Now it seems worth while to examine Stanton's opinion:—namely, whether on account of the poor results in non-calculous icterus, surgical interference in its presence is unadvisable. When we ask, "Is there a reliable criterion to determine whether a biliary colic with fever and jaundice is calculous or non-calculous?" the answer must be, "There is not."

We have seen that the presence of calculus alone is insufficient to explain the phenomena of a biliary colic. Stones—sometimes very large ones—may be carried in the common duct, either not causing any noticeable trouble, or with long periods of well-being between mild attacks. I have at present in my wards a Hungarian woman, who has been suffering for one year from acute gastric symptoms suggesting ulcer. Pain never appeared except about an hour after the ingestion of food, especially of meat. Being a rather intelligent woman, she observed, that by artificially inducing vomiting, partial relief was experienced; however, complete relief, only came when, at the termination of the act, a mouthful of bile was also ejected. There were but two appearances of icterus, one a year ago, shortly after the beginning of her trouble, the other recently, after her admission to the hospital; both times the icterus was not intense and of only a few days' duration. The stools always were normally colored. In this case an empty, almost normal, non-distended gall-bladder was found, with a cystic duct admitting the passage of the probe; the common duct was much dilated, its walls 4 mms. thick, it contained a cigar-shaped stone, 1½ cm. thick, and 5 cms. long, one of whose pointed ends engaged in the ampulla, so that a noticeable resistance had to be overcome in its extraction. One observation like this is sufficient to overthrow the ingenious ball-valve theory of Fenger, questioned by Robson and by other competent authors. If Fenger's theory held good, a fixed large calculus ought to produce as intense and progressive a form of obstructive jaundice as is observed in occlusion by cancer. I must repeat what was said before: that complete obturation of the papilla lasting a short time is generally due to the passage of small stones; that larger stones rarely cause complete obturation, but only maintain for short or long periods of time, varying degrees of relative obstruction. Biliary drainage can be so active in spite of the presence of a large stone in the common duct that it may, for longer or shorter periods, act as a check upon the development of the severer degrees of bile infection.

Another important question which has not received as yet a satisfactory answer, and which well deserves thorough investigation, presents itself. In health the duodenum is never free from the bacillus coli. What is it, that in a hitherto healthy individual, causes the first appearance of stagnation, thus serving to invite the change from normal bacterichola to bile infection?

Pregnancy, without any doubt, is a frequent cause of biliary stagnation, and we have alluded before to the interesting findings of Aschoff and Bacmeister bearing upon this subject. The nature of the minute anatomical structure of the gall-bladder and large bile passages offers another predisposing moment. We know that their muscular and elastic equipment is exceedingly feeble, so that their contractile energy, as measured by a manometer tied into the common duct, is not capable of raising the column of water beyond 220 mms. (Freese, Johns Hopkins

Hospital Bull., June, 1905.) The sphincter of the papilla represents the largest accumulation of unstriped muscular elements. Doyon (Archives de physiol., 1894, p. 19) has demonstrated that, after division of the vagus, irritation of the central stump will induce a contraction of the gall-bladder and common duct, with simultaneous relaxation of the normal tonus, by inhibition, of the sphincter, which thus becomes patulous. But to overcome the normal tonic resistance of the sphincter, a pressure of 675 mms. of water is required (Oddi).

What I am now going to say is purely theoretical and conjectural, and lacks confirmation; but as it offers a strong analogy with sphincteric action elsewhere, I beg permission to present it with a view to stimulating further exact investigation. We see that the pylorus and sphincter ani both show this peculiarity: They are maintained, in a state of tonic contraction, while the stomach and rectum respectively are at rest. As soon as the expulsive effort of a peristaltic wave brings contents down upon them, the amount of their normal tonus diminishes, spontaneous relaxation permits easy dilatation by the escaping chyme or fæces, after which the original tonic contraction is re-established. This modus also obtains as far as the ureters are concerned.

What, however, becomes of the normal sphincteric cycle, when local irritation of any kind supervenes? The normal tonus is augmented to a lesser or greater degree of spasm, which, maintained for a long time, first brings about hypertrophy, then degeneration and then the deposit of rigid connective tissue, contraction of which may produce actual stricture.[1] If this process holds good of all those sphincters whose function has been well studied, why should it not also obtain as regards the ampullary sphincter of Vater's papilla? Irritant matter passing the duodenum and leaving the papilla may certainly excite various degrees of inflammation, and even ulceration, in its vicinity, sufficient to exaggerate the normal tonus of the ampullary sphincter to a pronounced spasm, which the normal inhibitory impulse may not be sufficient to release. Viewing the feeble contractile powers of the gall ducts themselves, a small increment of sphincteric resistance will immediately determine a certain amount of relative obstruction leading to stagnation. This naturally will provoke an augmented effort of the musculature of the biliary tract, which, maintained for a long time, will end in muscular degeneration and ultimate dilatation. And this theoretical view of the process presents a logical sequence of events in perfect harmony with known physiological principles, and with pathological observation elsewhere. It also enables us to get a rational explanation of all the essential phenomena of febrile biliary colic, whether complicated by calculi or not. These calculi may modify the features of the morbid process, but they are not of its essence. This theory is also suggestive in other directions. It tends to clear up the frequent coexistence of gastric and duodenal ulcer in gouty subjects with biliary troubles.

I have recently ascertained, to my great pleasure, that Dr. J. Kaufmann of New York, one of the ablest pupils of Kussmaul, holds very similar views regarding the process which probably ushers in the great majority of all cases of infectious cholangeitis.[2]

Congenital atresia of the papillary orifice and faulty implantation, also of prenatal origin, may likewise serve as starting points of future trouble. Variations in the size of the papillary aperture (Robson, 2.5 mms.; Langenbuch, 3.8 mms.) may shade off into more or less pronounced atresia. Langenbuch (Deutsche Chirurgie, Chirurgie der Leber und Gallenblase, II. Theil, 156) quotes Konitzky's case of faulty implantation of the common duct into the duodenum, in which one half of the entire abdominal cavity of a girl of 21, was found occupied by a monstrously dilated common duct. This dilatation was caused by a relative obstruction of the papillary orifice.

Is restitution to the normal, anatomical standard possible, when dilatation of the bile ducts has once reached the stage of muscular atrophy and of fibrous thickening? This seems impossible. Yet the excellent, apparently durable results following prompt and

[1] Insufficiency and stenosis.

[2] American Medicine, vol. vi, No. 20, p. 792.

thorough surgical work seem to contradict this view; they also permit the conclusion that in these successful cases, a restitution of function may have been possible only because the contractile powers of the ducts were not destroyed beyond recovery.

We must mention, for the sake of completeness, the cholangeitis which so frequently complicates the hypertrophic form of hepatic cirrhosis, and also that, which accompanies the hepatic fever of early and late syphilis. Surgical measures might rationally be tried in the *former* (hypertrophic cirrhosis); in the latter, specific treatment is called for. In cirrhosis of the hypertrophic type, fatal cases are not rare; in them death is due not to cirrhosis, but to cholangeitis.

The most common examples of the milder degrees of infectious cholangeitis and cholangiolitis, are furnished by that vast group which are gathered together under the collective term of "catharrhal jaundice." From a transient access of this trouble, through the gamut of a long series of severer forms, all the way to the gravest examples of Weill's and Hanot's disease, there is no strict line of demarcation; the transitions are gradual, only representing variations in degree, none in substance.

Now a few words as to the therapy. I cannot share the discouraged attitude of Stanton, who deems it best to avoid surgical intervention in non-calculous cases of biliary colic. The fact that in 46 per cent of Ochsner's cases of this class, permanent cures have followed, is, on the contrary, full of encouragement. And I am happy to state that Naunyn, a master of the subject, and not a surgeon, unmistakably points the direction in which efforts should be made in the future. The calculous fetish has dominated this field so thoroughly and so long, that we shall need to overcome and revise prevailing opinions. Having once acquired the conviction that the fundamental factor of biliary colic and hepatic fever is infection of the bile, causing inflammation of the walls of the bile ducts, then, incision, drainage, and irrigation, will be accepted as necessary steps of a rational treatment.

To revert to the recommendations contained in Davis' paper, I found one there which deserves our utmost consideration. As the infection starts from the gut, and as the virulence of the bacteria is dependent on abnormal digestive processes which determine the character of the intestinal flora, the mere elimination of the causes of biliary stagnation will not cure the patient, unless, by appropriate dietary and remedial measures, such as the Carlsbad cure or its equivalents, the disordered functions of all the viscera connected with the processes of digestion and assimilation are corrected. As a matter of course, this principally refers to the gastric part of digestion, the beginning of so many of the troubles of the digestive tract.

To what extent the surgical principles of drainage and irrigation can safely be employed, for the cure of the graver forms of biliary disorder, future investigation and experience must teach us.

CONCLUSIONS

1. Every dilated common duct should be opened and drained.

2. Palpation should follow, not precede, incision of common duct.

3. An inflamed, thickened, adherent or shrunken gall-bladder should be removed.

4. All cicatricial deposits in gall-bladder or in cystic duct justify removal of gall-bladder.

5. The presence of many small stones, even though cystic duct is patulous, indicates that the gall-bladder should be removed.

6. The presence of a damaged gall-bladder is not an aid, but an impediment to exposure of the common duct.

7. Absence of the gall-bladder does not constitute an important adverse factor in the subsequent exposure of the common duct.

A CASE OF PSEUDOHERMAPHRODITISM[1]

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ALTHOUGH a large number of cases of hermaphroditism have been reported in the literature, we believe that authentic cases are rare enough to make an additional one worth reporting. Neugebauer (1) has collected from the literature 1,885 cases of all types. In many of these the true sex of the individual was never determined, and in others there is but little evidence of the type. Hermaphrodites are usually divided into the true and spurious, or pseudohermaphrodites. A true hermaphrodite, according to Ahfeld's definition, is "an individual with functionating active glands of both sexes, provided with excretory ducts." Such an individual is able to impregnate another or it may be impregnated. It may also impregnate itself. In reviewing the phylogenetic development of animals, we find that the cestopods may impregnate themselves, and, while gastropods can fructify each other indiscriminately, they are not capable of impregnating themselves. Examples of true hermaphroditism among the higher animals cannot be found. All cases occurring among human individuals belong, therefore, to the class of pseudohermaphrodites, or, as Tuffier and Lapointe (2) term them, "partial hermaphrodites."

Klebs (3) has divided cases of so-called true hermaphroditism into 1, unilateral, 2, bilateral, and 3, lateral. The lateral or alternate type is most common, and, in such animals as the pig, cases have been repeatedly demonstrated. According to him the unilateral type, that is, the individual possessing both ovary and testicle upon one side and a single organ upon the other, is by far the most rare. Tuffier and Lapointe adopt the conclusions of K. Meixner (4), who asserts that a separate ovary and testis have never been demonstrated in the same individual on the same side. Burrage (5), in his review of the literature upon hermaphroditism, has collected six cases of ovotestis in which there was definite microscopic evidence of ovarian and testicular tissue in the same organ. The majority of them occurred, however, in females, two of whom gave birth to children.

Neugebauer (6) has divided into *masculinus* and *femininus* those of his collected cases of pseudohermaphroditism in which the true sex of the individual was discoverable. These cases may also be classified according to the location of the malformation as *externus*, *internus*, and *completus*. The external type presents fully developed internal genital organs of one sex, with external genitalia resembling, to a greater or less degree, those of the opposite sex. The internal type, on the other hand, has normal external genitalia, the malformation occurring in the pelvic reproductive organs. This malformation may consist in a partially or completely developed uterus and adnexa, with a rudimentary development of those organs which arise from the Wolffian duct, as is to be found in the *femininus internus* type; or it may consist of normal male external genitalia — the *masculinus* type — with normal or partial development of the derivatives from the Wolffian ducts and rudimentary female organs derived from the Müllerian ducts. "The testicles frequently lie in the neighborhood of the uterus, where the ovaries are found in the female." The *completus* type consists of external genitalia resembling those of the opposite sex, while the derivatives of both Müllerian and Wolffian ducts are developed to a greater or less degree. The *femininus completus*, for example, has a hypertrophied clitoris and external genitalia somewhat resembling those of the male, while, in addition to ovaries and more or less developed derivatives of the Müllerian ducts, there are also some rudimentary derivatives of the Wolffian ducts.

[1] From the Surgical Department and Pathological Laboratory of the Michael Reese Hospital.

Neugebauer (7) shows the relative frequency of these various types in 910 cases in which the sex was determined:

External pseudohermaphrodites:	
Male	613
Female	181
Complete pseudohermaphrodites:	
Male	60
Female	3
Internal pseudohermaphrodites:	
Male	49
Female	4
	910

It is evident from the above table that about three-fourths of all cases are male. The external type is likewise far most common. This is to be expected, as the external anomalies are much more readily discerned, while the internal type is usually discovered either at autopsy or at operation, and even here cases may be overlooked.

The following case belongs to the *masculinus internus* type of spurious or pseudohermaphrodites. The patient, Mr. M., was admitted to the Michael Reese Hospital in the service of Dr. Greensfelder, December 14, 1910. His history was as follows:

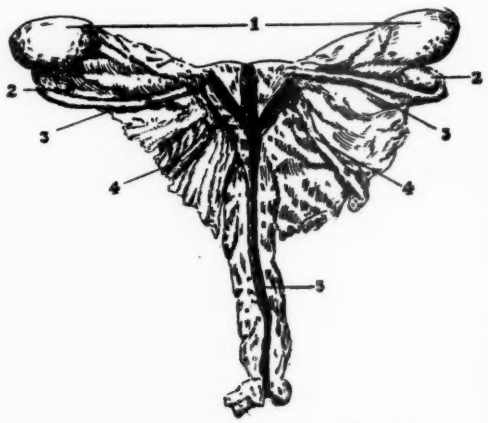
The patient was a dry goods buyer, American, 27 years of age, married and had one child. He entered the hospital on account of a dull, aching pain in the back and in the sacral region two or three inches above the anus. This pain had been present intermittently for eight months, during most of which time he had blood in the stools. He had been constipated much of the time, and had passed much gas and mucus per rectum. The patient had been operated upon for an inguinal hernia about eight months previous to the time he entered this hospital. He had been told, following the operation, that a uterus and ovary had been found. These are supposed to have been a part of the contents of the hernial sac. The patient had grown progressively weaker, and in less than a year had lost 39 pounds. He had had no cough and no night sweats. His previous and family histories were negative.

Physical examination revealed a well-developed, fairly well-nourished young man. The head and neck were negative. There was an abundance of hair upon the head and a heavy, closely shaven beard. The skin of the body was entirely negative except for the presence of an old herniotomy scar in the right inguinal region. The scrotum and penis were well developed. Neither testicle could be palpated in the scrotum. The right was palpated in the right inguinal region. Each external abdominal ring admitted the first finger readily. Upon rectal examination, the prostate was not enlarged. There was a distinctly nodular mass in the rectum, which extended beyond the reach of the finger. Physical examination was otherwise negative.

The diagnosis of carcinoma of the rectum was made and the patient operated upon by Dr. Greensfelder. When the condition described below was discovered, Dr. Frankenthal was called in and performed the gynecological part of the operation. The operation consisted in the usual mid-line suprapubic incision. Upon exploration of the abdomen, no free fluid was found. The broad ligaments were found in the usual location. In the position usually occupied by the uterus an organ was found, which resembled a uterus with a much elongated cervix, permitting the organ to rise up into the abdomen. In about the normal position of the ovaries were two oval bodies, which were thought at the time of operation to be ovaries. A tumor mass, about the size of a small apple, was adherent to the rectum, and there was other evidence of carcinoma. Numerous hard masses were present about the base of the organ which was supposed to be the uterus, and it also was thought to be carcinomatous. The broad ligaments were therefore clamped and cut and the "uterus and adnexa" were removed. About eight inches of rectum was then resected and the two ends of the gut brought together by an end to end anastomosis. There was no bleeding and the abdomen was closed. The patient was placed in the lithotomy position and a perineal incision made. A drain was inserted through the incision to the site of the anastomosis. The patient left the operating room in fair condition, but soon afterward passed into a state of profound shock from which he never rallied. He died December 21, 1910. The prostate and bladder were removed post-mortem.

The specimen removed at the operation consists of the two ovoid bodies thought at the time to be ovaries, but which proved to be the testicles (No. 1 in figure), two triangular-shaped bands, the broad ligaments, and an elongated, roughly cylindrical mass lying between them (No. 5 in figure). This mass represents the uterus. The seminal vesicles are placed upon either side of the uterus and empty into the prostatic urethra.

The testicles are each 4 cm. in length and 2 cm. in thickness. The right is slightly larger than the left, being 2.5 cm. in width, and the left but 2 cm. The distance between them is 10 cm. Upon microscopical examination, they are found to be covered by a thick capsule of dense fibrous tissue representing the tunica albuginea. The testicular substance is composed of numerous convoluted tubules varying from 90 to 150 microns in diameter. These are held together by a reticulum of connective tissue in which there are many interstitial cells and numerous thin-walled blood vessels. There is an excessive amount of this reticulum and the interstitial cells



1. Testicles. 2. Epididymes. 3. Vasa deferentia. 4. Fallopian tubes. 5. Uterus.

are much more numerous than are found in a normal testicle. The epithelial lining of the tubules is, in many places, shrunken from the basement membrane. The cells nearest the basement membrane are small and rich in chromatin. Some of the tubules present a second layer of cells with less distinctly staining nuclei. Numerous sustentacular cells are present. The centers of the tubules are filled with a loose, homogeneous reticulum, such as is seen in exudates. There is no evidence of the formation of spermatozoa.

There is a small oval body (No. 2 in figure) just below each testicle, and extending a little external to it. The oval mass lying below the left testicle is 2.5 cm. in length and 0.7 cm. in diameter. The similar body on the right side is 1.5 cm. in length and 0.8 cm. in diameter. Microscopical examination shows these bodies to be epididymes. Ducts (No. 3 in figure) lead from these smaller bodies to the central mass — the uterus — and pass close to its sides until they empty into the prostatic portion of the urethra. These ducts are about 20 cm. in length, and have an average diameter of 5 mm. Upon microscopical examination, they are found to be lined with a closely set columnar epithelium. The submucosa consists of a loose fibrous connective tissue with numerous thin-walled blood vessels. Surrounding this, the muscularis is circularly arranged and the other features of the vas deferens are present.

The central mass is 13 cm. in length and 7 cm. in its widest portion, which is at the entrance of the tubes into the cornua. The elongated "cervix" is 8 cm. in length and has a lumen varying from 2 to 8 mm. in diameter. The walls vary from 6 to 10 mm. in thickness. The entire posterior surface of the body is covered with peritoneum, but it has been cut away from the anterior surface. The peritoneal serosa covers both surfaces of the broad ligaments. Microscopically, the mucosa of the uterus is lined by a layer of simple columnar epithelium. There are pouchings of the mucous membrane, but no true glands are found. There is relatively little fibrous tissue beneath the epithelium. The musculature is composed of many bands of smooth muscle fibers, the nuclei of which are shorter than normal. These bands run in a variety of directions and are loosely bound together by an increased amount of connective tissue between them.

Ducts, representing the Fallopian tubes (No. 4 in figure), run downward and outward from the two cornua between the layers of the broad ligament. The right ends blindly, without any evidence of fimbria formation. It is 6 cm. in length and is 5 mm. to 8 mm. in diameter. The left was sectioned at operation. The portion of the tube remaining with the specimen is 5 cm. in length and has the same general diameter as the right.

F. Lucksch (8) reported a case similar to the one herein reported. His case was that of a man 45 years of age, who died of generalized tuberculosis. It agrees with our own case, even to the presence of an inguinal hernia. This hernia contained a vas and a tube. While we do not know what contents the operator really found in the hernial sac of Mr. M., from the data given in the patient's history, it undoubtedly contained a testicle and vas, and possibly a tube. Lucksch found fimbria at the extremity of the left tube. As the tube had been sectioned in the removal of the specimen, we are unable to state whether our case agrees to this extent or not.

In conclusion, we wish to thank Dr. James W. Jobling for the microscopic sections of the specimen and for numerous helpful suggestions.

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REPORT ON EXOPHTHALMIC GOITER BASED ON THE EXPERIENCE OF THE MEMBERS OF THE CHICAGO SURGICAL SOCIETY[1]

By WILLIAM FULLER, M. D., Chicago

THE following report on exophthalmic goiter represents the collective views of the members of the Chicago Surgical Society on a few practical points in this interesting, but as yet imperfectly understood, affection of the thyroid gland.

A greater number of the reports submitted by the fellows of the society represent personal observations and experiences in Graves' disease, covering in most instances periods varying from three to five years; while a few reports include all the work in this line covering periods of time much longer than five years. As many of the members were unable, owing to a lack of time, to furnish data on all their exophthalmic goiter work, together with a few who sent no reports at all, we have only about six hundred operated cases on which to base this report.

The questions propounded did not call for information or expressions of opinion from the members of the society on any mooted or unsettled points covering the functions of the thyroid gland, or its relations to other endosecretory organs; but were framed with the intention of eliciting a few opinions based on a personal knowledge of Graves' disease. The information thus obtained deals with the extent of experience, the methods and choice of treatment, percentage of cures, mortality, and end results, under five headings as follows:

1. What has been your experience with exophthalmic goiter, (*a*) as to the extent of work done in this line, (*b*) methods of treatment employed, and (*c*) percentage of cures obtained as regards thyrotoxicosis and secondary changes?

2. What particular operations have you employed; what methods do you suggest in various types and conditions now; what preliminary treatment, if any, do you use?

3. What have been your results as to mortality; (*a*) immediate, (*b*) remote?

4. What constitutes, in your judgment, a cure in exophthalmic goiter?

5. In what class of cases of thyroid enlargement do you advise operation; in what type of hyperthyroidism would you advise operation and in what type would you advise *no* operation or conservatism?

EXPERIENCE, TREATMENT AND CURE

Of the six hundred cases reported on by members of the surgical society more than eighty per cent of the cases were subjected to medical treatment before surgical measures were instituted. A few of the members of the society are enthusiastic as to the efficiency of appropriate and properly conducted medical treatment of exophthalmic goiter. Two of the reports contained short accounts of the benefits that were obtained by medical treatment in the severest types of Graves' disease with which the authors had ever met. The cures were apparently complete and permanent.

Of all therapeutic aids short of surgery none appears to have such decided benefits as complete rest enforced for long periods of time. Proper hygienic surroundings, carefully selected diet, the administration of sodium cacodylate, quinine hydrobromate, etc., are also regarded by many of the surgeons as valuable adjuvants in the pre-operative or medical management of Graves' disease.

Fully eighty-five per cent or more of the cases of exophthalmic goiter are cured by operative treatment as regards both thyrotoxicosis and secondary changes in other organs. A few of the cases are not improved by operations either in the toxicity of the disease or in the complications. One member of the society puts this number as high as fifteen per cent; while others, or the majority, have had few cases that were not improved by operation as to both thyrotoxicosis and secondary changes.

[1]Read before the Chicago Surgical Society, March 1, 1912. (See discussion, p. 626.)

The improvement that follows an operation is usually prompt, but a few reports mentioned the fact that the benefits of surgery in Graves' disease are sometimes delayed. One member of the society noted in an instance or two the first signs of improvement delayed for several weeks.

A few cases that showed improvement immediately went on to athyroidism. One of the members of the society had this unfortunate result follow ligation of the superior poles, with subsequent fibrosis of the entire thyroid gland finally resulting in the patient's death. A similar change occurred in the thyroid of a patient under the care of the same surgeon; in this instance no operation of any kind was performed and the hypothyreosis which quickly followed was due to a preexisting thyroiditis. A single report records the fact that after a considerable number of operative cases of Graves' disease, in no instance was the cardiac function completely restored, nor did the exophthalmos entirely disappear.

METHODS OF OPERATING

The operative procedures used by the various members of the society for the hypertrophied thyroid gland as well as in exophthalmic goiter, are practically one and the same as regards method or technique. A Kocher operation, with or without division of the muscles overlying the goiter, is used by the majority; a few expose the goiter by incisions parallel with the sternomastoid muscle.

Considerable difference of opinion is expressed regarding the extent of surgery necessary in the several degrees or types of Graves' disease. The variation as to this necessity is seen by equally as complete cures in exophthalmic goiter, the result of simple pole ligation, as in operations which ablate more than half the gland. The entire membership of the society, with a single exception, not alone aims to meet the indications in each and every case by a wisely selected time for the operation, but makes an effort to select that particular surgical procedure that will do no more than is just sufficient to suppress the hyperactivity of the gland. Drainage is important and is recommended in all operations by all the members. Special stress was laid upon the foregoing points by more than one member of the society, and one report was so very emphatic that the author's own words may be quoted: "Excision of one lobe and the isthmus in the largest number of cases; one lobe, the isthmus and the lower portion of the other lobe in the next greatest number of cases; excision of one lobe and ligation of either the superior or inferior thyroid vessels in the next largest number of cases; and preliminary ligation of the superior thyroid vessels in the smallest number of cases."

Another report divides the cases of exophthalmic goiter into "*very mild*" and "*extremely bad*" cases; both of which are met by ligation of the thyroid arteries. The author of this report claims a cure will follow this procedure in the mild cases, and that the extremely bad cases will so improve from this procedure that any subsequent surgical treatment is without danger. The cases of exophthalmic goiter between these two types are treated by the author of this report by the removal of half the gland, plus the occasional ligation of the thyroid arteries.

An effort is made by all the members of the society to leave intact the posterior capsule of the thyroid gland, thus avoiding the recurrent laryngeal nerves and the parathyroid bodies. It is therefore quite evident that the society, in both medical and surgical treatment of Graves' disease, is practically a unit.

MORTALITY

The immediate mortality in the six hundred operated cases of Graves' disease was not estimated to be higher than about five per cent. As to remote mortality nothing tangible or definite could be obtained. A very notable feature in some of the reports was a decrease in death rate with increase of experience in the operative work. One operator, in a first series of cases, had a mortality of 7 per cent; while in a second, and a much larger series, his operative mortality was 2.2 per cent.

The causes of death were not mentioned except in few instances. The anæsthetic was held responsible for death in a very few cases;

while the acute exacerbations or the operative hyperthyroidism, was supposed to be the cause in the greater per cent of fatalities. Ether is, by most of the members of the society, the anæsthetic of choice, while local anæsthesia, in the experience of those who have used it, is not recommended.

As to the definitions of "cure" of exophthalmic goiter as given by the members of the society, some difference of opinions is noted. Some of the fellows regard as cured any patient able to resume his ordinary occupation in life, regardless of the persistence of the exophthalmos and some of the cardiac changes. Other members of the society look upon the exophthalmos and other secondary manifestations, when they remain even to a slight degree, as proof that a cure, in the common acceptation of the term, has not been reached. If all the toxic symptoms disappear after an operation, although a slight exophthalmos remains and the cardiac changes markedly improve or become arrested, a few members of the society would classify these with the cured cases. Under this heading it may be mentioned that one report expresses a growing skepticism as to permanency or a continued beneficial effect of surgery in Graves' disease.

INDICATIONS FOR SURGERY IN AFFECTIONS OF THE THYROID GLAND

Surgical treatment is indicated in thyroid enlargement as voiced by a majority of the reports in, (1) goiter of undue size, producing by its own weight embarrassment to the act of respiration. In this class would fall cases with (*a*) irritating cough, produced by the goiter, (*b*) difficult swallowing, due to pressure of the goiter, (*c*) deformity; and (2) all cases of hyperactivity of the thyroid gland which are not at the same time suffering with acute exacerbations of the disease and in which other less radical measures have shown their inefficiency.

The danger line in exophthalmic goiter is represented by the acute and sudden attacks or exacerbations of hyperthyroidism; the "margin of safety," to paraphrase one report, is here encountered, and the frequent failure to appreciate this point, furnishes satisfactory explanation of a higher mortality in one series of operated cases than another, or, possibly, in the work of one surgeon than another.

Conservatism is urged in the radical therapy of Graves' disease, occurring in young girls at the beginning of puberty; the rest treatment with other means of palliation should be persisted in longer than in older patients or until proof is positive that the case is amenable to no other treatment than surgery. In this connection it is worthy of mention that one of the cases in a series operated by one of the members of the society, was that of a girl of seven years of age whose symptoms persisted for more than three years in spite of medical treatment. An operation on this young girl was followed by satisfactory results and the case was regarded as a cure. Neglect, oversight, or bad judgment otherwise used may, in the treatment of hyperthyroidism, carry a case to such a critical and far advanced state, that surgery, even ligation of the thyroid arteries, will become a dangerous procedure. Such are regarded as the inoperable cases, and radical measures are not then regarded by most surgeons with favor.

A short summary of the several reports here embodied, and showing the consensus of opinion of the society on the subject of exophthalmic goiter pertaining to the points designated by the questions propounded, shows the thyroid gland in its various degrees of altered function to be successfully managed by the following measures:

1. Rest, hygiene, and suitable medication, persistently employed for a reasonable length of time.

2. Limiting the blood supply to the gland by ligation of one or more of its arteries.

3. Ligation of one or more of the thyroid arteries, with removal of a greater or lesser portion of the thyroid gland.

4. A combination of two or more, or all of these therapeutic aids.

A few valuable suggestions from some of the members of the society on points not referred to by the questions may, with advantage, be included in this report. A plea is made for a more detailed study in all cases of goiter or thyroid disease presenting symptoms of

excessive activity of the gland, and a closer discrimination in the selection of cases for surgical treatment.

The full advantage of surgery in the treatment of exophthalmic goiter is realized only when this treatment is employed early; before complications and marked changes in other organs become the conspicuous features of the affection. On the other hand attention is drawn to the fact that there is a prevailing tendency among some surgeons to unhesitatingiy operate on all forms of thyroid enlargement without evidence of thyroid intoxication, on the assumption that such cases are in reality cases of early Graves' disease.

Some credence must be accorded this hypothesis when the fact is recalled that the histologic pictures of many of the so-called colloid goiters are identical in every detail with many cases that are classified in the category of diseased thyroids now designated as exophthalmic goiters.

In both types of thyroid disease there is to be seen the same intra-alveolar infolding and proliferation of the epithelium, with some of the cases eventually exhibiting signs of hyperfunction of the gland, while others do not present such manifestations and are probably the true colloid goiters. The correct interpretation of this question still awaits further investigation and until the facts are more definitely established, fallacies, such as statistics estimated on so unfair a basis, should be fully appreciated and given no consideration in an effort to formulate a rational therapy in Graves' disease.

Finally it is advised that some effort be exerted in the treatment of all cases of Graves' disease to determine the extent of surgery necessary for a cure, and that any procedure too far reaching in its ultimate or remote effects, or likely to exceed this need, be strictly avoided.

The myxœdematous, or, as it is sometimes called, the third stage of Graves' disease, regarded by Osler as the third cousin of the primary condition, is a possibility too important and too serious to overlook. This condition of athyroidism, following medical as well as surgical treatment, has been observed by members of this society, and is more than likely, when following radical treatment of exophthalmic goiter, to reflect discredit on surgery of the thyroid gland.

CONCERNING THE FUNCTION OF THE CORPUS LUTEUM AND SOME ALLIED PROBLEMS[1]

By GEORGE F. DICK, M. D., and ARTHUR H. CURTIS, M. D., Chicago
(From the Department of Pathology, University of Chicago)

THE present report represents ideas derived both from experimentation upon animals and from a study of the literature devoted to this subject.

The essential facts concerning the corpus luteum which have been demonstrated during recent years are obtainable only by reading an enormous amount of literature. The most important anatomical characteristics have been determined by Sobotta. In a study of the development of the corpus luteum in the mouse, he followed with painstaking care every change in the character of the corpus luteum from the time of earliest formation consequent to follicular rupture, through complete development, until it becomes atrophic and physiologically inactive. Sobotta found that the follicular epithelium is in a state of proliferation immediately upon extrusion of the ovum. Supported by a framework of connective tissue and blood vessels, it soon fills the entire cavity of the follicle and when fully developed forms a gland-like mass of polygonal-shaped cells, rich in lutein and strikingly similar to adrenal tissue in both gross and histological appearance.

[1] Read before the Chicago Gynecological Society, April 19, 1912.

The so-called corpus luteum "verum" which is associated with pregnancy, differs in no respects from the corpus luteum "spurium" which develops at other times. The once universal, and still popular, belief that the corpus luteum of pregnancy is larger and provided with more active cells than the corpus luteum unassociated with pregnancy is now known to be erroneous.

The function of the corpus luteum was first studied by Fraenkel [1] (1903). In a later paper (1910) Fraenkel [2] recorded the results of further experiments upon rabbits which, in essential features, were confirmatory of his previous findings and may be summarized as follows: The corpus luteum is necessary for the development of the fœtus during the first half of pregnancy. Destruction of corpora lutea during this period results in absorption of the embryos. If the ovarian tissue be destroyed, and the corpora lutea left intact, pregnancy is not interfered with. There is no evidence whatsoever of a difference between the corpora lutea of pregnancy and those unassociated with pregnancy. Fraenkel also attempted, ineffectually, to demonstrate that the phenomenon of menstruation is dependent upon the corpus luteum and periodically coincident with it.

Niskoubina [3] (1908) and others repeated Fraenkel's experiments and corroborated his findings.

Attempts to disprove Fraenkel's claims that the corpus luteum has the function of governing the insertion of the ovum and of insuring its further development have been repeatedly made. Of all contradictory evidence, that of Mandl is most convincing. Mandl transplanted the left ovary of a pregnant rabbit extraperitoneally between the fascia and abdominal wall, without severing the ovary from its broad ligament pedicle. Consequent to normal labor and two days following coitus the right ovary was removed. The new pregnancy progressed undisturbed. The transplanted ovary revealed no evidence of corpora lutea either upon gross or microscopic examination. From this experiment it was concluded that the corpus luteum is not necessary for the development of the fœtus.

The experiments of Leo Loeb (1909) [4] (1911),[5] concerning the function of the corpus luteum, are of interest and of value. By making incisions into the uterus or by the introduction of foreign bodies into the uterine cavity, he is able to produce decidual tumors. These he obtains only when corpora lutea are present in the ovaries. If the corpora lutea are removed at the time of incising the uterus the decidual tissue either fails to develop or is limited in amount. Loeb removed the corpora lutea during later stages of pregnancy and found that new ones develop, thus indicating that it is not the pregnancy, but the prolonged function of the corpus luteum in pregnancy, which prevents new ovulation in pregnant animals.

Bouin and Ancel [6] (1909) placed virgin rabbits with bucks which had been subjected to resection of the vas deferens. Copulation was followed by the formation of corpora lutea which attained full development in the usual period of two weeks. Associated with this occurred uterine evolution, characterized by enormous increase in size and great hypertrophy of the musculature, together with thickening and increased convolutions of the mucosa. With degeneration of the corpora lutea occurred coincident involution of the uterus. When the corpora lutea were destroyed within a few hours of their first appearance the uterus presented no modifications; if destroyed after several days' development an immediate cessation of uterine changes resulted. Bouin and Ancel conclude that the corpus luteum, which is the only new factor present in their experiments, produces uterine changes preparatory to the development of pregnancy, and that if pregnancy does not occur, the further uterine alterations coincide with the various phases of luteal development and degeneration.

In our animals it was noted during laparotomy that an enlargement and congestion of the uterus similar to that observed by Bouin

[1] Arch. f. Gyn., 1903, lxviii, 438.
[2] Arch. f. Gyn., 1910, xci, 705.
[3] Compt. Rend. Soc. de Biol., Par., 1908, lxv, 767.
[4] Centralblatt f. Physiol., 1909, xviii, 73.
[5] Deut. Med. Wchnschr., 1911, xxxvii, 17.
[6] Soc. de Biol., Par., 1909, lxvi, 505. Jour. de Phys. et de Path. Generale, 1909, xii, 1.

and Ancel occurred in non-pregnant rabbits when corpora lutea were present.

Experiments on pregnant animals. In our experiments, removal of both ovaries within the first two weeks of pregnancy caused absorption of the embryos in every one of a series of fourteen pregnant rabbits. Removal of one ovary resulted, once in absorption, five times in normal development to full term. In several rabbits, one ovary was transplanted on a pedicle into the anterior abdominal wall. Pregnancy thereafter occurred in two of these and the second ovary was removed to note whether the transplanted ovary, devoid of corpora lutea, as in the case of Mandl, was capable of keeping up the pregnancy. The results were in confirmation of the ideas of Fraenkel. Contrary to the results obtained by Mandl, in both instances absorption of the embryos followed castration. These attempts therefore failed to prove that the ovary without corpora lutea can maintain pregnancy.

In further study of the function of the corpus luteum it was desired to produce an anti-corpus-luteum serum. This we wished to use for the purpose of inhibiting or counteracting the action of the normal corpus luteum during pregnancy. Beebe [1] (1910) reports the production of cytotoxic organ-specific serums by repeated injections of the nucleoproteid of certain organs. Thus he produced a specific nephrotoxic serum, also a hepatotoxic serum and a serum for the treatment of exophthalmic goitre. At the Union Stock Yards of Chicago, we obtained an abundance of beef ovaries from which were removed the functionally active corpora lutea. These were finely divided and by means of a laborious and rather complicated process, the details of which are of no especial interest in this connection, the corpus luteum nucleoproteid was obtained. Roosters and guinea-pigs were now injected at intervals of a few days with increasing doses of the nucleoproteid. Following the maximum number of injections which could be given without a fatal result, the serum of the immune animals was used for agglutination tests with suspensions of finely ground corpus luteum. There was no evidence of the development of specific antibodies in the serum when compared with the serum of normal animals. The injections were given at different intervals and in varying amounts and the serum was obtained at varying intervals after the last injection, but in no case was a specific anti-serum obtained.

Next was tested the value of corpus luteum nucleoproteid when substituted for normally functionating corpora lutea. Two rabbits were castrated during pregnancy and treated by subcutaneous, slowly absorbing injections of the nucleoproteid. Absorption of the embryos resulted. Two rabbits which were likewise castrated during early pregnancy were treated with injections of extract of freshly ground corpus luteum. Absorption of the embryos resulted. Our attempts to secure a continuation of pregnancy in rabbits by use of fresh beef corpus luteum or its derivatives were therefore unsuccessful.

Experimental transplantation of ovaries. The experimental transplantation of ovaries is intimately connected with the solution of problems concerning the function of the corpus luteum. That ovaries can be successfully transplanted has been demonstrated by Knauer,[2] Gregorieff,[3] Ribbert [4] and others.

For practical purposes, however, success is limited to reimplantation of ovarian tissue into the subject from which it was removed. Work upon rabbits would indicate that this is the only type of transplantation which can be undertaken with reasonable hope of resultant functional activity. No one has succeeded in securing successful transplantations from a series of animals into others of the same species (homotransplantation) or into others of different species (heterotransplantation). Isolated instances of homotransplantation have been successful, but these are so rare that the hope of obtaining a successful result in any given case is extremely small. Knauer was the first to successfully transplant ovaries, and his work is more quoted than that of any other worker in this field. In autotransplantation (reimplantation into the animal from which removed) he met with success.

[1] Trans. Cong. Amer. Phys. and Surg., 1910, viii, 36.

[2] Zentralbl. f. Gyn., 1896, xx, 524. Arch. f. Gyn., 1900, lx, 320.

[3] Zentralbl. f. Gyn., 1897, xxi, 663.

[4] Arch. f. Entwickelungsmechanik, 1898, vii, 688.

In transplantation from rabbit to rabbit (homotransplantation) growth of the ovary in the new position occurred only twice and in neither instance did functional activity result. Franklin Martin,[1] who recently presented an excellent review of the present status of this subject, is sanguine regarding the success of autotransplantation. In discussing transplantation from patient to patient he gives the impression that failures are now the rule, but anticipates that future experimentation will make this procedure a success. Sauve [2] (1910) after a most exhaustive study asserts, in résumé, that human ovarian grafts are of very limited use in practice and that the most enthusiastic (Morris, Mauclaire) have performed not more than twenty grafts during the last ten years.

Our experiments in the transplantation of ovaries have convinced us that success is not the rule. In a series of operations for transplantation, performed upon rabbits after a thorough study of methods advocated and results achieved by those conversant with this work, we have made thirteen autotransplantations and twenty-one homotransplantations. Some ovaries were transplanted whole, others were divided before transplantation. Subsequent examinations were made at the expiration of periods ranging from two weeks to four months. Some ovaries were found considerably decreased in size, but the majority were not. Had examination been restricted to inspection we could easily have believed that the transplantations were successful. Upon palpation, however, the consistency was less firm than normal and on bisection the surfaces appeared somewhat dry and putty-like. A central cavity was frequently present. Histological preparations were made from various parts of each specimen. A degeneration of all follicles except some of large size was characteristic. The stroma was fairly well preserved, although invaded by great numbers of eosinophiles. Corpora lutea which had been present at the time of transplantation were frequently persistent and unaltered. The interstitial cells not only remained active but appeared to develop in their new location. Luxuriant growth of the parovarium, easily to be confused with epithelial proliferation, was evident in a few specimens. Yet the complete picture was one of undoubted regression and degeneration, without enough evidence of vitality to justify the most hopeful in stating that these ovaries were capable of normal function. Three exceptions were two autotransplantations of five weeks and of two months respectively, and a homotransplantation of four weeks' duration. These ovaries contained abundant numbers of active follicles, normal interstitial cells, and well-preserved stroma. They were undoubtedly functionally active.

In consideration of some factors involved in these experiments on transplantation,— firstly, that the literature was thoroughly studied previous to performing the operations, secondly, that the toxic action of ether anæsthesia was avoided, thirdly, that the operations were performed with utmost despatch, and fourthly, that infection did not complicate our results, we feel that the results obtained were as favorable as the average operator is warranted in anticipating. If this be granted, the transplantation of ovaries is an operation which does not yield a high percentage of satisfactory results.

The interstitial cells of the ovary. In microscopic characteristics, and probably also in physiological activity, the interstitial cells of the ovary bear a close relationship to the corpus luteum. These cells arise from the theca interna and form large gland-like masses consisting of nests of cells, very similar in appearance to those of the corpus luteum. In the rabbit the interstitial cells often comprise a large part of the entire ovary and have every appearance of active glandular tissue. The fact that interstitial cells cannot be found in human ovaries and in the ovaries of some of the lower animals with spontaneous ovulation, makes less likely a claim that they produce an internal secretion which is essential in the metabolism of sexual life. Although the interstitial cells appeared active in the large proportion of the ovaries transplanted by us, they were incapable of maintaining pregnancy after removal of the animal's own ovaries.

[1] Surg. Gyn. and Obst., 1911, xiii, 53.
[2] (Abstract) Amer. Jour. Obst., 1911, lxiv, 674.

Relation of the adrenals to the ovaries. Other glands with internal secretion, notably the adrenals, the thyroid, and the hypophysis, are so closely interwoven in physiological activity with the function of the ovary and its corpus luteum that they must be constantly reckoned with, in studies of this nature.

It is claimed by Schenk [1] that removal of the ovaries results in compensatory increase in size of the adrenals, and that the histological changes thus produced are also typical and constant. The microscopic changes he describes consist in hypertrophy of the zona reticularis of the cortical portion of the adrenal, which is composed of light staining, large, clear, highly-active cells situated beneath an outermost layer of less active, smaller, more deeply staining cells.

To determine the interrelation between the adrenals and ovaries we removed ovaries from sexually active rabbits and at the expiration of varying numbers of months autopsies were performed. The adrenals were weighed and the ratio of their weight to the weight of the eviscerated animals was computed. Several normal rabbits were killed for controls. The gross and microscopic characteristics of the adrenals from the previously castrated animals were contrasted with corresponding tissue from the control rabbits. A glance at the accompanying table shows that the ratio of adrenal weight to body weight in the castrated animals is .00032, whereas the normal control animals have also a ratio of .00032. Removal of ovaries therefore does not cause an appreciable increase in size of adrenals.

RATIO OF WEIGHT OF ADRENALS TO BODY WEIGHT IN CASTRATED RABBITS

Animal No.	Wt. of Adrenals	Body Wt. Eviscerated	Ratio	Days Elaped Since Castrations
20	440 mg.	1420 g.	.31	100
39	650 mg.	1500 g.	.43	45
59	320 mg.	1270 g.	.24	60
61	580 mg.	1550 g.	.37	60
62	390 mg.	1430 g.	.27	60
63	520 mg.	1080 g.	.47	60
77	480 mg.	1700 g.	.28	30
78	380 mg.	1450 g.	.26	30
82	360 mg.	1450 g.	.25	60
		Average	.32	

[1] Deut. Med. Wchnschr., 1911, xxxvi, 1735.

RATIO OF WEIGHT OF ADRENALS TO BODY WEIGHT IN CONTROL RABBITS

67	500 mg.	1150 g.	.43	
80	350 mg.	1320 g.	.26	
81	500 mg.	1930 g.	.26	
83	150 mg.	900 g.	.16	
85	220 mg.	1050 g.	.20	
86	540 mg.	880 g.	.61	
		Average	.32	

In microscopic specimens we were unable to confirm the changes which Schenk considers characteristic. On the contrary, there was no evidence of any changes in the adrenals of castrated animals which served to distinguish them from control specimens which were prepared at the same time and with the same technique.

In further study, adrenals were removed from sexually active rabbits and transplanted into baby rabbits and into sexually mature rabbits. Autopsies performed at later dates were negative as regards changes in the ovaries or adrenals of the recipient. The transplanted adrenals were absorbed either partially or completely, in direct proportion to the length of time which elapsed before autopsy.

From these experiments we are led to doubt the claim that the adrenals and ovaries mutually undergo compensatory changes when the function of one or the other of these organs is less than normal.

An experiment of interest in this connection is that of Stocker,[2] who transplanted the ovaries of a cow into a two weeks calf, which thereafter developed a typical rickets. At autopsy the transplanted ovaries were reported to be functionally active, the calf's own ovaries normal, and its adrenals scarcely to be found. To repeat this experiment we transplanted the ovaries of three mature guinea-pigs into three baby pigs. When development had proceeded until the attainment of about two-thirds adult size, autopsies were performed, normal pigs from the same litters serving as controls. None of the three animals presented signs of rachitic changes or other developmental peculiarities which distinguished them from the control animals, although the ovaries which had been trans-

[2] Zentralbl. f. Gyn., 1911, xxxv, 109.

planted into one of the animals contained corpora lutea and follicles in every stage of development.

CONCLUSIONS

1. Our results support the claim of Fraenkel that the corpus luteum is apparently essential for the development of the fœtus during the early part of pregnancy.

2. Attempts to produce an anti-corpus-luteum serum according to Beebe's method were unsuccessful.

3. Autotransplantation of ovaries yields success in a rather small percentage of cases. Homotransplantation is considerably less successful.

4. Removal of both ovaries fails to cause either adrenal hypertrophy or microscopic evidence of increased physiological activity of the adrenals.

5. Attempts to produce experimental rickets by means of transplantation of ovaries were unsuccessful.

CHORIO-EPITHELIOMA OF THE TESTICLE

With Report of a Case

By C. B. KEENAN, M. D., Montreal
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A PATIENT, aged twenty years, was admitted to the Royal Victoria Hospital on January 2, 1908, under the care of Dr. Garrow, complaining of a painful enlargement of the right testicle. This enlargement had been first noticed on October 1, 1907, after a slight blow to this part, but as it was then painless the patient did not at once seek medical advice. As the testicle had reached the size of a goose-egg in two weeks, the patient entered a hospital, where a week's rest in bed caused an apparent diminution in the size of the tumour. Subsequently the swelling again returned, and was now accompanied by pain. The patient accordingly entered this hospital as above stated.

On admission, the right testicle was found to be represented by a mass closely resembling a goose-egg in size and outline. This mass was not tender, but it gave rise to a dragging pain in the groin whenever the patient stood erect. Other than the above, the patient's condition appeared normal in every respect.

On January 3, 1908, the tunica vaginalis was opened and found to contain about four ounces of thin, bloody fluid. A necrotic-looking mass was attached to the upper pole of the apparently unaltered testicle. The testicle mass, and as much as possible of the seemingly healthy cord, was removed for examination and the wound closed. From the examination of the tissue of the necrotic-looking mass I ventured a provisional diagnosis of chorio-epithelioma, and reported to the surgeon that in a short time the development of metastases might be expected. The wound healed nicely and the patient left the hospital, apparently well, in a fortnight. On February 28, 1908, the patient wrote to Dr. Garrow, stating that he was becoming very pale, that he felt faint after the slightest exertion, and that a small reddish nodule had developed in the skin over the right scapula. An examination of the blood showed that the hæmoglobin had now fallen to 30 per cent and that the red cells were only 2.775 million per c. mm.

On March 28, 1908, the patient was readmitted in order that the nodule on the skin could be excised in order to ascertain whether it might confirm the original diagnosis. This operation was performed the next day, and the examination of the nodule proved that the diagnosis of chorio-epithelioma was correct. From this time on the patient sank rapidly, with progressing anæmia and with the development of numerous metastases. He died on May 15, 1908.

As the chief interest in the above case centers in the nature of the tumour, this will now be discussed in detail.

1. *The growth in the testicle.* Examination of the testicle after removal showed a mass about half an inch in diameter attached to the upper pole of the epididymis and projecting into the cavity of the tunica vaginalis. It had the appearance of an old blood-clot, did not infiltrate the testicle proper, and was surrounded by freshly extravasated blood. Microscopic examination of the mass showed that by far the greater portion consisted only of necrotic tissue and blood-clot, while a small remnant proved to be new growth.

This new growth consists chiefly of moderately large polyhedral cells with clear cytoplasm, which frequently shows vacuoli where glycogen globules have been dissolved out in the process of reparation (Fig. 1).

The nuclei of these cells tend to be round, and are frequently vesicular, rich in chromatin and very often show mitotic figures. There are also a few very large multi-nucleated cells to be seen in the sections. In cells of this second type, the cell body stains rather deeply (Fig. 2) with hæmatoxylin, and shows a coarsely reticular structure (the so-called foamy appearance). Large vacuoles are also often present. These cells are usually found in the neighborhood of a small vessel, but they do not seem to be exercising any destructive influence on this. Transition forms between these two types of cells are present. There is no intercellular substance or reticulum, but there is a stroma consisting of very embryonic fibrous tissue bearing very thin-walled blood-vessels.

A third noteworthy feature is the occurrence of a few irregularly shaped, empty spaces, lined by a layer of cubical cells, or by what appears to be simply a nucleated mass of protoplasm that strongly suggests the syncytial layer of a chorionic villus, the more so because a villus-like projection of the wall into the lumen is seen in places. At times these projections have a small central vessel (Fig. 3), and the nucleated mass of protoplasm, or the short columnar cells into which the mass sometimes changes by surrounding this vessel, produces the so-called perithelial arrangement which has occasionally led writers to class these tumours as peritheliomata. The cells that line the spaces merge insensibly into the two previously described forms.

The above findings, taken with the extensive necrosis and hæmorrhage, justified a provisional diagnosis of chorio-epithelioma to be made, although it was felt that this diagnosis could only be considered as certain when a metastasis could be examined. Later, when examining other portions of the testicle tumour, a small cyst was found that separated easily, and sections of this showed it to have a wall of myxomatous or very young fibrous tissue covered by a double layer of epithelial cells (Fig. 4). The outer layer consisted of nucleated protoplasm that at times was heaped up in a syncytial-like mass, while the inner consisted of separate, darkly-staining cells. This structure was comparable with that of a chorion at a very early period.

2. *The metastasis in the skin over the scapula.* The study of the structure of this nodule showed that the provisional diagnosis had been correct. This growth appeared to consist of two distinct types of tissue. The one was made up of large, clear polyhedral cells with large, rather deeply-staining nuclei that frequently showed mitotic division (Fig. 5), while the other is better described as consisting of a very large, coarsely reticular (the so-called foamy structure), often vacuolated protoplasmic mass, in which lay very numerous nuclei. These large masses usually appeared to be placed peripherally in regard to the polyhedral cells. At times they presented a knobbed outline, and, again, they extended in long anastomosing bands enclosing spaces with or without a content of detritus or red blood-cells (Fig. 6). They very often showed the brush-like edge or ciliated appearance that is characteristic of syncytial cells, as pointed out by Wlassow (4) and by Pick (9). Careful search, however, showed that transition forms between the polyhedral cells and the large protoplasmic masses could frequently be found.

Relation to vessel walls. The new growth cells were often found to invade and destroy the vessel walls in such a way that part of the circumference of the vascular channel consisted of normal endothelium while the remaining portion was formed by a large syncytial mass (Figs. 7 and 8). Many vessels were found to be filled by the new growth cells. Here there was no new stroma formation, and there was marked necrosis of the surrounding tissue.

The testicle tumour had been carefully searched for tissue suggesting other than an ectodermal origin, but none could be found. Of course, the stroma must be of mesodermal origin, but since it is comparable to the stroma found in ordinary epithelial growths, it could not be assumed that the testicle tumour was

derived from a double-layered "anlage" and that it was a teratoma.

Characteristics of the cases described in the literature. These tumours are still very rare, as may be judged from the fact that, up till 1908, only five had been reported by American observers, viz., three by Frank (1) and one each by Orton (2) and Longcope (3).

Microscopically, these growths appear to be made up chiefly of old and freshly extravasated blood, and they have usually a well-defined margin.

While the microscopic picture of the mestastases in all the reported cases is practically the same as our case, that of the primary tumour may vary greatly. This variation is accounted for by the fact that chorio-epithelioma of a testicle often contains many other teratomatous elements, such as cartilage, bone, mucous cells, or neuro-epithelium, but one will always find areas of rather large polygonal cells which usually show abundant glycogen and round, deeply-staining nuclei that often show mitotic figures. Associated with these will be found large multi-nucleated and irregularly shaped cells whose cytoplasm tends to take the basic stains, shows numerous vacuoli, and presents a coarsely reticular structure (the so-called foamy appearance). The nuclei of these large cells are placed indefinitely throughout the cell body, stain deeply and have been described as showing

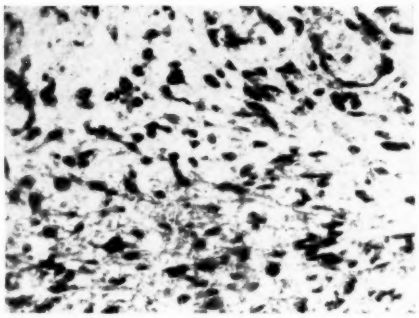

Fig. 1. Micro-photograph of the growth in the testicle, showing polyhedral cells with vacuolated cell body. 500 diam.

a mitotic division. These cells are usually found in the neighborhood of a small vessel and are sometimes so scanty that they would not be seen, save on careful examination. These two types of cells correspond closely to the two types of epithelium that cover a normal placental villus. The former represents Langerhans' layer and the latter the syncytium, while, as in a placenta, transition forms between the two types can be found. To Wlassow (4) falls the credit of first pointing out that in these tumours the large cells are formed from the small ones by confluence, a fact that had already been proven for placental syncytium by Marchand (5). Also there

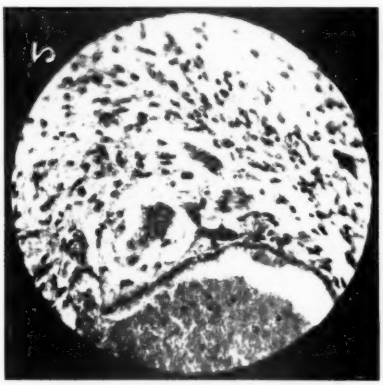

Fig. 2. Another portion of the same section as Fig. 1, showing multinucleated cells close to blood-vessel. The cell body stains rather deeply. 300 diam.

Fig. 3. Portion of the same tissue showing villus-like projections into a space. The individual cells covering these villi are very similar to those of chorionic villus. 300 diam.

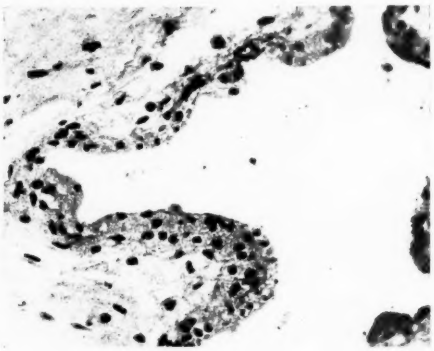

Fig. 4. A portion of the wall of a cyst showing the myxoid character of the connective tissue and portions of villi at the edge. 500 diam.

is marked degeneration of the surrounding tissue associated with extravasation of blood. There are often small empty spaces, lined by cubical epithelium, or simply by a nucleated mass of protoplasm which often projects into the lumen like a papilla and may have a central thin-walled vessel. It is this arrangement that has caused some observers to term these tumours peritheliomata.

The nature of the tumour. These tumours were first described in 1878 by Malassez and Monod (6) as angioplastic sarcoma, because of resemblance of the syncytial masses in the metastases to the vaso-formative net of Ranvier. Wlassow (4), in 1902, showed that these growths were epithelial in nature and that, as seen especially in the metastases, the large multinucleated masses had a vaso-destructive and not a vaso-formative action. He also pointed out, as indicated above, that the two types of cells found in these growths had a common origin and that the form taken by the individual cell was probably determined by its required function.

He remarked on the similarity of these tumours to the chorio-epitheliomata of the female, but did not consider them to be of the same class, because the tumour in the male would then come under the category of teratoma, whereas proof could not be found that the tumour was derived from a three-layered anlage. In other words, the original tumour did not contain derivatives of ecto-, endo-, and mesoblast.

Later, in 1902, Schlagenhaufer (7) brought forward a malignant tumour of a testicle which clearly showed derivatives of all these three layers and provided conclusive proof that it was a teratoma. This case, also presented a typical chorio-epitheliomatous structure in the original tumour which contained solely the latter type of growth. Schlagenhaufer now concluded that all similar tumours of the testicle had their origin in the primitive chorion of a teratoma which he derived (in accordance with the Marchand-Bonnet theory) from a separated blastomere. He went even further, and stated that tumours, developing from such teratoma, would probably be met with, which would show all the characteristics of hydatidiform mole. A case reported by Breus (8) was an example of this. Schlagenhaufer's first conclusion was supported by a case reported by Pick (9), where a chorio-epithelioma developed from an ovarian dermoid, and by Ritchie's (10) case of a similar tumour arising from a mediastinal dermoid. It also gains support from the frequency with which teratomatous elements have been found in chorio-epitheliomata of the testicle when these tumours have been carefully examined. His second conclusion has been strongly combated by Risel (11) and has not found general acceptance.

Marchand (12), in 1903, questions Schlagenhaufer's view that chorio-epithelioma come from a primitive chorion, or rather that a teratoma is necessary for the development of such a tumour. He thinks that the fœtal ectoderm has the power to give rise to such tumours and finds support in the cases reported by Pick (9), Emanuel (3), Wlassow (4) and Risel (11), where there was an intimate connection between the chorio-epitheliomatous parts and the fœtal neuro-epithelium. He recognizes the value of Obendorfer's statement that the value of such transformation pictures should not be overestimated, because they may only mean the invasion of one type of tissue by another.

Steinert's (14) case of a chorio-epithelioma of a testicle containing teratomatous elements, not only in the primary growth but also in the metatases, can only be explained on the ground

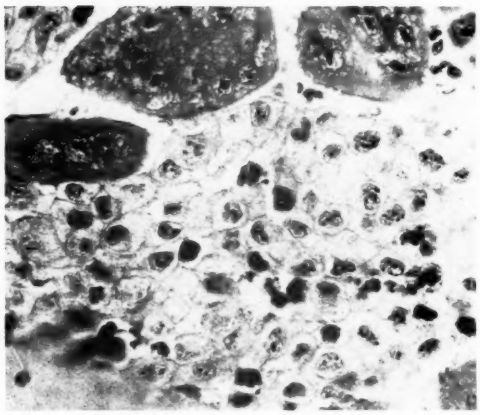

Fig. 5. Tissue from the skin metastasis, showing in the center large, clear polyhedral cells with mitotic figures. As a periphery of this group of cells are several massive giant cells exhibiting foamy structure and numerous nuclei. 700 diam.

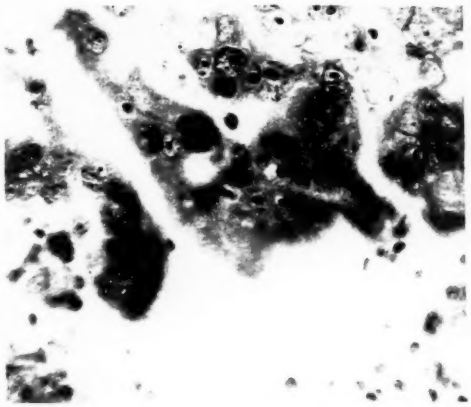

Fig. 6. Another portion of the same tissue as Fig. 5, showing a few of the very large vacuolated cells with most of the nuclei. 700 diam.

that the cells of this growth came from fœtal blastomeres, which separated so early that they were capable of producing all three layers. After reporting a case of a chorio-epithelioma of a testicle that showed transition forms between the chorio-epitheliomatous tissue and the neuro-epithelium very plainly, Risel confirms Marchand's view with the statement that the "chorio-epitheliomata only show a special form of growth out of the many ones that fœtal ectoderm can exhibit."

Sternberg (15) claims that many of the so-called chorio-epitheliomata of the testicle

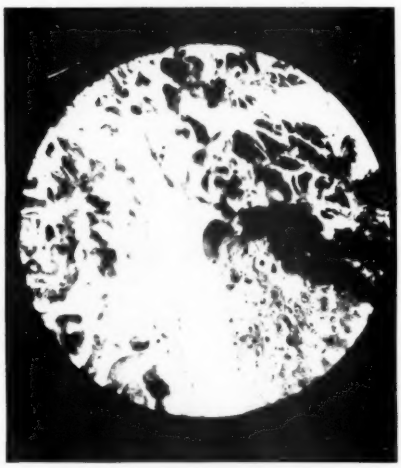

Fig. 7. A portion of the same tumour showing a cleft across the middle with tumour nodule projecting into it. The cells of the nodule are similar to those of Fig. 5. 300 diam.

Fig. 8. Portion of Fig. 7, more highly magnified, showing giant cells of the type seen in Fig. 6. 700 diam.

are really endotheliomata or peritheliomata, and he emphasizes the fact that giant cells in a testicle tumour do not justify its classification as a chorio-epithelioma. His view finds qualified support by Risel, who has been influenced by the close resemblance that the metastases of non-chorio-epitheliomatous tumours clearly bear to those of these tumours.

One must admit that the diagnosis from the primary tumour is almost impossible, but where both the primary growth and the metastases come under observation and exhibit the above features there can be no reasonable doubt that we are dealing with a typical chorio-epithelioma. One would like to emphasize the ciliated or brush-like margin of the giant cells in these tumours, as this may aid in distinguishing them from the oridnary giant cell.

In conclusion, I wish to thank Dr. Gruner, Pathologist to the Royal Victoria Hospital of Montreal, who kindly prepared the illustrations for this paper.

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DEPARTMENT OF TECHNIQUE

TECHNICAL POINTS IN PROSTATIC ENUCLEATION[1]

By J. BENTLEY SQUIER, M. D., New York City
Professor of Genito-Urinary Surgery, New York Post-Graduate Medical School and Hospital

IN an article which appeared in the September, 1911, issue of Surgery, Gynecology and Obstetrics, the writer briefly outlined a method of suprapubic prostatic removal for hypertrophy which has many merits.

A number of requests having been forthcoming for a more complete description of the principal variations from the usual technique of suprapubic prostatic removal; therefore, it is here given in detail.

During the past year, a number of observers have brought forth data which tend to explain certain facts concerning the anatomy of prostatic enlargement. Most notable is the work of Tandler and Zuckerkandl. In a comprehensive series of dissections they proved that enlargement always begins in the glandular tissue situated around the urethra behind the verumontaneum.

The median lobe is now known to be a distinct and definite division in the glandular development of the prostate, and is so constant a factor in the production of urinary obstruction, that it is time that its full significance be recognized.

Fully to appreciate the phenomena of prostatic hypertrophy, a knowledge of certain embryologic phases in the development of the gland are essential. As early as the third month of intrauterine gestation, the mesoblastic tissue around the lower ends of the Mullerian and Wolffian ducts becomes thickened, in the situation of the wall of the primative urethra (Wilson and McGrath.) The epithelium of the sinus urogentalis throws off three groups of buds on each side. Two of these are on the dorsal aspect of the urethra, beginning as one mass and later dividing into a cranial and a caudal group. One is on the anterior aspect of the urethra.

The anterior group atrophies at an early period and is usually absent in the adult. These buds consist of epithelial tissue lying in a mass of mesoblastic tissue and do not acquire a lumen until after birth.

As the prostate develops to its final normal state, specialization takes place in these different groups of glandular tissue so that definite zones appear. If the musculoconnective tissue be dissected away from the gland, separate lobes may be differentiated as follows: A small anterior group; two lateral groups; an interposed median lobe; and a posterior lobe or commissure.

The lobules of the different groups have fixed points for the emptying of their excretory ducts into the urethra, and for this reason the designation of lobes to the various groups may be given.

The excretory ducts of the anterior lobe empty into the prostatic urethra on its anterior wall opposite the verumontaneum, the ducts of the median and lateral lobes on the floor and sides.

The prostate is penetrated by the urethra and the ejaculatory ducts. At the base of the prostate, these canals are separated by the median lobe, but are united anteriorly at the situation of the veru.

In the majority of cases of prostatic enlargement, this wedge shaped mass of glandular tissue, the median lobe, is the starting point of hypertrophy and becomes the main factor in the production of urinary obstruction. The floor of the prostatic is in relation to this lobe from internal

Plate 1.

[1] Extract from a paper read before the Buffalo Academy of Medicine, April 30, 1912.

Plate 2.

meatus to colliculus. Anterior to the colliculus the prostatic urethra is in relation to the posterior lobe or commissure. The urethra is not connected to the prostate gland by any ducts in front of the colliculus.

In regard to the morphology of prostatic hypertrophy Runge and Chiari, in their recent research, agree that in the largest percentage of enlarged prostates the process is an adenomatous overgrowth, independent of inflammation and neoplastic in character.

Plate 3.

Plate 4.

Another fact is pertinent, that there is no anatomical capsule to the prostate, when considered from a surgical viewpoint. The line of cleavage which simulates a capsule during operative removal, is merely a layer of compressed glandular tissue, at the periphery of the enlarging lobe. Such being the case, the portion of the prostate removed during operation is the adenomatous overgrowth of the centrally situated secreting glandular zones; the lobes of the prostate which are intimately associated with the urethra through the prostatic ducts, namely the lateral and median lobes.

Further, during the process of hypertrophy the prostate, from being an extravesical organ, becomes an intra and extra-vesical one. The internal sphincter of the bladder has changed its position from apposition to the base of the prostate to one encircling it.

The enucleation which I advocate is based upon this change in position of the internal sphincter muscle, and allows of restoration to its normal position with preservation of its integrity.

Plate 5.

Plate 6.

This method of enucleation can be readily understood by referring to the series of plates.

Plate 1. Here is shown the symmetrically enlarged prostate, projecting into the bladder, raising the urethral orifice and displacing the internal sphincter muscle outwards away from the urethra. The lateral lobes are seen to lie in apposition just above the meatus.

Plate 2. Enucleation is commenced by pushing the finger into the internal meatus and breaking through the roof of the urethra at the point where the lateral lobes lie in apposition. The finger is necessarily within the encircling fibres of the sphincter.

Plate 3. The finger frees the lateral lobe in front and at the side and the lobe is delivered into the bladder.

Plate 4. The finger is carried around below the median lobe, the other lateral lobe is then loosened (Plate 5) and the prostate is tipped up in the bladder (Plate 6) and the urethra severed close to the median lobe, posterior to the colliculus. An irregular cone shaped cavity remains, lined with compressed prostatic tissue covering the uninjured ejeculatory ducts. The internal sphincter remains intact and soon contracts to its normal calibre. The cavity produced by removal of the prostate eventually contracts and repair becomes complete by the torn mucous membrane of the bladder uniting with that of the severed urethra. If unusual hæmorrhage is encountered it is possible to easily pack the cavity, as the action of the restored sphincter aids in retaining the packing.

Plate 7. Illustrates a simple method of packing the cavity. The gauze packing is brought out of the suprapubic tube, and allows of removing the packing without disturbing the tube.

The old method of enucleating the prostate through intravesical incision in the mucous membrane over the most prominent hypertrophy, carries with it the probable destruction of the internal sphincter, the danger of severe hæmorrhage from opening into the plexus of Santorini and almost certain injury to the ejaculatory ducts.

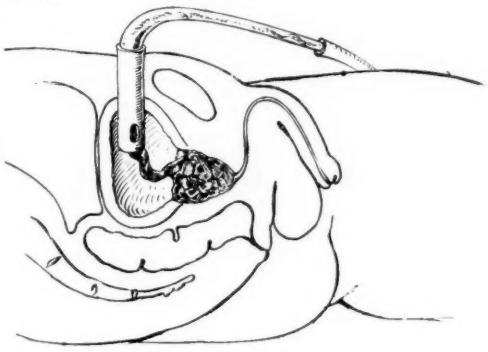

Plate 7.

THE X-RAY IN GYNECOLOGY

Review of the New Evidence

By ROBERT L. DICKINSON, M. D., Brooklyn, New York

UNTIL gynecologists of standing personally investigated series of cases of diseases of the female genital organs before and after treatment by the Röntgenologists and verified their claims to success, skepticism was natural. The corroborations of the last three years are of such weight, however, and the formulation of indications is becoming so definite, that a summary of reported results demands consideration. If these results are borne out by further experience then it seems that, *in a very considerable group of cases, for those who can afford the time and expense, and have access to the X-ray therapeutist* (as distinguished from the diagnostician), *resort to hysterectomy is no longer warrantable without trial of the ray. This group includes all the intractable menorrhagias of chronic metritis and all myomas requiring treatment except those infected, degenerating, submucous or polyp, and those suspected of malignancy. The older the patient, the better the response. All fibroids are said to shrink, all hæmoglobin percentages to rise.* To the profoundly anæmic and to the graver cardiac and nephritic and arteriosclerotic risks there is a remedy to offer. And, as Menge bluntly puts it, if the surgeon refuses consideration of this method the practitioner and the public will take up the matter.

The most comprehensive and satisfactory history of the X-ray therapy applied to the practice of gynecology has been written by Manfred Fraenkel of Charlottenburg in his book, "Die Röntgenstrahlen in der Gynekologie mit einem Ausblick auf ihren Künstigen Wert für Sociale und Sexuelle Fragen" (Berlin, Schoetz, 1911); and in his article in the *Berliner klinische Wochenschrift*, April 24, 1911. He gives the total number of X-ray cases at about four hundred and traces the work of the various operators in the following order:

Halberstaedter shrank the ovaries of animals to nearly half their normal size. He noted recovery after shrinkage, and, in proportion to dosage and damage, return to full size and function. From his own experiments Fraenkel worked out a scale of dosage for women which, obviously, is only approximate and empirical.

The next work was that of Deutsch on myoma with as many as ninety treatments on a patient. After this came the French operators Laquerrière and Foveau de Courmelles. Laquerrière reported thirty cases with success at the menopause but none of these were young women. De Courmelles had good results in forty-five cases, getting effects by about thirty treatments to a case.

Fraenkel's work was next in order, 1907–1909.

Albers Schönberg proved the effect of the X-ray on myoma in 1909. He found that intramural fibroids respond best, and condemned the use of the X-ray for submucous fibroids, an experience corroborated in several instances. He records a number of artificial climacterics.

Fibroma of uterus. Fraenkel [1] writes a long article with full literature and many excerpts. His claim is that three quarters of his myoma cases were successful, generally with shrinkage. He thinks the most pronounced effect is on the ovaries. The treatment may cause increased bleeding if the time of irradiation corresponds to a menstrual period. Gauss and Krönig agree with this.

Schindler says that before operation every case should have trial of X-rays. The treatment may produce thyroid enlargement or reduce an over large thyroid.

Schönberg was the first to apply this therapy in Germany. His work was verified by gynecologists. He gave six to nine treatments of six minutes each. He noticed increased bleeding in a few cases, one death resulting from it. Only two fatal cases are given in the literature (but these may not rightly be attributed to this treatment). He excludes patients much run down and those with cardiac dilatation.

Schindler-Görlitz (a gynecologist and X-ray operator) reports ten cases in the two years previous to March, 1910, and seven successes. One patient, fifty years old, with fibroid as large as four months' pregnancy, had bleeding and pain checked in eleven treatments. In a few months the tumor became one third the size. In another case, fifty-one years old, a fibroid as large as a three months' pregnancy, bleeding freely, disappeared. He cites three more recent cases in which the tumor shrank one half. No increased bleeding was seen by him.

Krönig and Gauss [2] of Freiburg, saw the

[1] Berl. klin. Woch., 1911, 17, 760.

[2] Roentgenstrahlen in der Frauenheilkunde. Muench. med. Wchnsch., 1910, xxix, and Kongress, 1910.

treatment induce exhaustion and headache and nausea and vertigo, but the symptoms soon passed. Flushes preceded the artificial menopause. In ten cases of myoma, two shrank quickly. In thirty-eight cases there was bleeding. In 60 per cent this was checked; in 30 per cent, increased. In one case the increase was marked. Gauss concludes, "One can no longer deny the great advantages of the deep ray. The inoperable, anæmic, cardiac, and bronchitis cases are those best suited to this method."

Hænisch of Hamburg, Lose of Bremen, Reifferscheid of Bonn, find those near the menopause most responsive. No observer has seen growth stimulated. Matthei of Hamburg reports six successes in eleven cases and observes that the chances of good results increase with the years of the patient. No skin troubles occurred. Faber of Jena (Franz's clinic) reports striking shrinkage in five cases.

Bordier of Lyons [1] publishes a very full technical article concerned with the treatment of fibroma. He mentions, without references, the work of Deutsch and Imbert, Foveau de Courmelles, Bergonie, Spader. Pollosson, professor of clinical gynecology of Lyons, verifies his reports covering five months. Bordier claims that bleeding stops after two or three series of treatments and the fibroma lessens in size. Artificial menopause may be induced with negligible disturbances. In every case menorrhagia was checked and menstruation was stopped and did not reappear. The indications cover relatively recent tumors, since those twelve to twenty years old atrophy but little. Contraindications are degenerative fibroids and those which are cystic.

These Bordier histories are hardly satisfactory to us as gynecologists in certain details. For example, he gives size of full term pregnancy as reaching just above the umbilicus. There are eighteen cases fully itemized. Pollosson saw several before treatment. The cases varied in duration, some histories covering two years. Two of the cases classed as fibroma are said by Bordier to be really chronic metritis. The histories do not tally with actual measurements of pregnancy. Nor is his claim justified that all of his observations are corroborated. We must choose, in his report, between two horns of a dilemma. He is either palpably inaccurate or else all of the eighteen cases shrank amazingly and all stopped bleeding astonishingly. Other observers substantiate many of his claims.

Up to this point, Fraenkel's book covers the literature.

[1] Arch. Roent. Ray, August, 1911, No. 133, 92.

While the consensus of opinion is that X-ray treatment is expensive, Kelen [2] thinks otherwise, as a session once a month suffices. He uses the Keinbock-Walter dosage, 30–40 cm. from the skin, and he sees every myoma shrink, those near the menopuase more quickly than the others.

The latest paper, and that carrying weight with the gynecologist comparable with the Krönig and Gauss report and the Franz history, is the very full article from the Heidelberg clinic by Eymer, with a study of indications and results by Menge, in the Monatsschrift für Geburtshilfe und Gynekologie, xxxv, 3, 1912, 268. It covers three years and includes one hundred and sixty-four pelvic cases, among others ninety-four myomas, forty-six uterine diseases, and ten hæmorrhages from adnexal disease.

In patients over 40, the periods can be stopped; between 30 and 40, lessened. In older patients lighter dosage will produce effects. All myomata and metropathic conditions showed betterment in weight and hæmoglobin, and most myomata shrank. The disturbances were the same in character as after surgical castration. Occasional irritation of the bladder and bowel were met with, but were temporary. Treatment was not intermitted during periods of bleeding. It covered two to four months for fibroids, four to ten sessions of three successive days with fourteen day intervals.

Menge declares that because of the difficulty of diagnosis between pelvic tumors, and the need of knowledge of indications, the gynecologist should direct the X-ray treatment, which is of long duration and considerable expense. He groups indications as follows:

1. *Myomas calling for operation:* Large, rapidly growing tumors; all submucous polypoid growths; adenomyomata; cases infected, and degenerating, or those suspected of malignancy; younger women (below 40) with free bleeding and rapid development (leaving the ovaries), and, lastly, myomectomy for the few younger individuals keenly desirous of children.

2. *X-ray* for all elderly patients with tumors of whatever size, particularly those that are stationary, not bleeding or causing kidney or heart blockade, or crowding the pelvis; those in women deeply anæmic, diabetic, nephritic, bronchitic, arteriosclerotic, or with bad hearts or large thyroids.

3. *Leave the smaller tumors showing no symptoms alone.*

Brilliant results were seen where the hæmoglobin was 15 per cent and 20 per cent. Eymer

[2] Budapest Monatssch. f. Gyn., xxxiv, 2, 1911, 160.

and Menge advise disregard of a temporary increase of bleeding caused by the treatment and deny that the two much emphasized fatal cases of Schönberg were due to the ray. Menge concludes that the X-ray will save from the surgeon's knife most of the myomata that demand measures of relief, because these are usually in women over 40. To surgery belong, in general, cases needing interference that are under 40, those in whom conservation entire of the ovarian activity is desirable, all infected, degenerating, and malignant cases, and those suspected of being in the last three groups.

Sterilization. Reifferscheid found in big animals, and in six women, degeneration of the epithelium of Graafian follicles over the whole anterior aspect of the ovary, and also cortical hæmorrhages, after the deep ray.

Fraenkel affirms that even after the checking of hæmorrhages with the X-ray, patients became pregnant. He arrested the periods in a tubercular patient for a year and a half, until she had time to grow better. He sterilized a heart case "within a year." Later she menstruated and conceived. Peritoneal exudates are not awakened to activity. A case of menorrhagia in a young woman, not checked by two curettings, was bettered in five sessions of six minutes. Patient had had two children; syphilitic husband. In three months short periods, then abortion. Vigorous X-ray treatment brought period to one and one-half days, and two or three sessions, at half monthly intervals, produced relative sterility of a year in spite of exposures. He refers to such an effect as "temporary castration."

Albers Schönberg affirms that in the male the generative faculty may be diminished, or checked entirely, in proportion to the dosage of the X-ray, but that erectile ability may be affected very little or not at all, or may even be increased. Regeneration comes "some time later," as microscopically demonstrated. [Several X-ray operators, after abandoning practice, have had children.]

Fraenkel indulges in many speculations suggesting an X-ray course for perverts and sexual criminals instead of castration, for which he thinks the public is not yet ready.

Metritis, chronic. Fraenkel observes that the best results in chronic metritis were in enlarged uteri rather than in the small.

Ovarian affections. Judging from the literature and his own experiments Saretzky[1] recommends X-ray treatment of the ovaries in the following instances: 1. Affections of the ovaries which indicate their extirpation. 2. Affections of the genital organs in which suspension of the ovarian function appears to be desirable, as (a) benign uterine tumors, (b) menorrhagia and metrorrhagia and chronic metritis near the climacteric. 3. Osteomalacia. 4. Circumstances in which the suppression of ovulation activity is desired, as in absolute pelvic contraction, tuberculosis, etc. 5. Indications for induced abortion. The author employed X-ray treatment in a case of a 34-year-old patient with chronic oöphoritis of both sides set in so that oöphorectomy was proposed. Constant pain, menstruation eight days, always profuse, with severe dysmenorrhœa. For two months the usual conservative therapy was tried without result. After that X-ray of each ovary separately in sessions of five to ten minutes. After nine sessions, menstruation of three days, quantity diminished, without pain beforehand. In five months, with nine sessions, menstruation had ceased to occur and at the end of that time neither ovary could be felt; they had apparently atrophied.

Fraenkel thinks that the ovaries of older women are more easily affected than those of younger women as they are ready to atrophy.

Sexual hyperæsthesia. Fraenkel quotes a case of Schönberg's, relating to a woman, who, with little self-control in any direction, weakly yielded to every sexual impulse which might be excited, even at the sight of a man. Here, he suggests, the X-ray may exercise a "temporary castration" to the point, at least, of lessening the diseased emotion and so procuring recovery for the depleted body.

For reducing excessive genital irritabilities and combating nymphomania a field may well be found here.

The literature for all the sections in the foregoing paragraphs is so fully given in Fraenkel's book and article that the references need not be here repeated.

Technique. Bordier uses his chromo-radiometer and aluminum filter. Enormous quantity of irradiation is desired without too severe skin reaction. His unit was (iodine liberation) 5 to 15, or Benoist's 11–12 radiochronometer. The aluminum sheet is .5–3.5 mm. Each series covers nine irradiations via three routes, ovarian and median. The interval is two or three days according to what the skin will stand. Treatment of sides and middle line not given the same day. Six days of treatment and then interval of three weeks, and then six treatments followed by interval of three weeks. Generally there are four or five series.

[1] Saretsky, S. G. Ein Versuch der therapeutischen Roentgenization der Eierstöcke. Jour. f. Geb. u. Gyn., 1900, i, 6.

After second treatment, erythema or browning occurs and there is less flow or none.

Dr. Curtis Webb [1] is publishing this technique.

The instruments used by Eymer of Heidelberg were a 50 cm. induction coil of Richard Seifert and Co. of Hamburg and a Wehnelt interrupter. Müller tubes were used principally, also those of Bauer and Gundelbach's. In some of the later treatments, Müller's water cooled tubes were used.

The treatments were given in most cases from the abdominal side, with the patient lying down. A large diaphragm was used. The cylinder was pressed in as deeply as possible with the aid of a loofah. A vaginal radiation was never undertaken, except in the case of a disease of the vulva. To prevent irritation of the skin, one or two thicknesses of leather were laid over the skin. The face, breast and neck were protected with a lead shield. A focus of thirty-eight cm. from the skin was maintained by means of the diaphragm. Hard tubes were used, usually seven Walter, sometimes six, the hardness being regulated by a Walter scale. The secondary current had an amperage of one to two milliampères.

Exact determination of the dosage is as yet impossible. The authors used the Holzknecht scale and also Keinböck's method. In order to avoid dermatitis, the authors consider it best to give trial radiations of some portion of the skin for six to seven minutes for three consecutive days with a tube of the desired hardness and a given amperage of the secondary current, and discontinue treatment for at least fourteen days, in order to observe the skin reaction.

In most cases treatment was given immediately after menstruation; but in some cases of metrorrhagia, when the periods were irregular and long, continued treatment was given during the bleeding. The duration of the treatment was from two to four months, in a few cases five months, the treatment being given in four to ten series. In the treatment of myoma, each exposure lasted from twenty-four to two hundred and eight minutes (the latter in one case only), with a secondary amperage of about one milliampère or less. In the treatment of metropathy, the longest exposure was one hundred and sixty seven minutes. In the treatment of diseases of the adnexa, the length of the exposure varied from ninety-eight to one hundred and seventy-six minutes, usually about one hundred and ten minutes. In dysmenorrhœa, treatments of twenty-seven to thirty minutes were given; in pruritus vulvæ, a treatment of eighteen minutes. In cases of peritoneal tuberculosis, two cases were treated by sixteen exposures of one hundred and twenty-eight minutes; one by twelve exposures of seventy-two minutes, and one with exposures of fifty-three minutes (treatment continuing at time of report). In radiation following operations, exposures of eighty-eight to one hundred and forty-two minutes were given from sixteen to twenty-one sittings. In peritoneal tuberculosis and after radical operations, the X-ray may be beneficial and should be tried. Smaller dosages should be employed with older women.

I am indebted to Dr. E. C. Titus for drawing my attention to the number of witnesses testifying to this method of treatment and to Drs. L. G. Cole and A. F. Holding (all of New York) for translations of the technicque. X-ray directions are couched in terms no mere clinician can grasp.

In brief, the technique that has given results in the X-ray treatment of selected cases of gynecology has been:

Current — derived from an induction coil;

Interrupter — Wehnelt, mercury turbine or mechanical;

Milliampère reading — 1.0 to 2.0; usually 1.0;

Penetration — Wehnelt, 9 to 10; Walter, 6 to 7;

Radiation— measured by Keinböck, Holtzknecht, or Bordier chroradiometers;

Filter — one thickness sole leather wet, or two layers sole leather dry, aluminum;

Time of treatment — between menstrual periods if possible (except in the operative cases, where the treatment should be begun as soon after the operation as possible);

Series of treatments required — two to ten, usually four;

Tubes — heavy anode or water cooled tubes, seasoned so as to stand heavy currents and yet maintain a high vacuum;

Position of patient — usually lying on back;

Compression blende and protection of other parts of the patient's body used.

[1] Ref. see Jour. A. M. A., August 5, 1911, p. 514.

SPINAL ANÆSTHESIA; WITH REPORT OF SURGICAL CLINICS

HELD AT THE SAMARITAN HOSPITAL, PHILADELPHIA, NOVEMBER 8 TO NOVEMBER 15, 1911, BEFORE THE CLINICAL CONGRESS OF SURGEONS

BY W. WAYNE BABCOCK, M. D., PHILADELPHIA

SPINAL ANÆSTHESIA. For the past six years spinal anæsthesia has been largely employed in our surgical clinic, and nearly three thousand five hundred intradural injections have been made. At the present time, all serious operations below the level of the diaphragm are performed under spinal anæsthesia, unless the patient or family physician objects to the method. In grave forms of sepsis, serious renal disease, or inflammation of the respiratory tract, we usually insist upon this form of anæsthesia. The method facilitates the operative manipulation, shortens the time of the operation, increases the degree of muscular relaxation, reduces the intra-abdominal traumatism, diminishes the length of the incision necessary, and increases the post-operative comfort of the patient. In certain cases the spinal anæsthesia may render an operation unnecessary. It relaxes or paralyzes the sphincter ani, and, by blocking the inhibitory innervation of the intestine, it produces a marked peristalsis and a distinct reduction of the caliber of the bowel. Thus in coprostasis, and in forms of intestinal obstruction due to spastic ileus, certain types of volvulus, or kinkage, the induction of spinal anæsthesia alone is sufficient to remedy the condition. Twice in forms of intestinal obstruction which had lasted for days, and had resisted other methods of treatment, have we had the bowels to move and the abdominal distention to disappear upon the operating table as we were about to start the operation. Frequently in operating for strangulated hernia, or even inflammatory ileus, an evacuation will occur before completing the operation. The method in itself may also be curative in certain hysterical or neurotic conditions; dramatically so for spasticities or contractures involving the lower extremities. The mental impression as the neurotic patient sees his rigid limb suddenly melt into flaccidity is overwhelming.

We do not consider spinal anæsthesia a universal anæsthetic nor one well adapted to general use. Its use demands greater precision and a more careful technique than is required of the average etherizer. It may be dangerous or ineffectual if not skillfully administered, and it should be employed only by those who have carefully mastered its principles. For the rough, careless operator, or the operator who has insufficient self-control, or the operator who requires much time for his operations, the method will not commend itself. If properly used in the routine of surgical work, spinal anæsthesia will be found to have a very low mortality, and in certain cases to be life saving. If its use is restricted to nearly moribund patients, and to those beyond hope by other methods of anæsthesia, the operative mortality will be high. I believe that no other anæsthetic gives an equal degree of relaxation with so little danger. While it will prevent the development of shock, it will also increase grave forms of pre-existing shock and in such conditions, or others which have seriously depressed the vital centers, it should not be employed, at least by the novice. Age is no contra-indication to the intradural injection, as we shall hope to show you.

We have tried most of the substances suggested for spinal anæsthesia, and at the present time employ the following solution:

Stovaine, 0.08 grams.
Lactic Acid C. P., 0.002 cc.
Alcohol, C. P., 0.2 cc.
Distilled water, 1.8 cc.

The solution is freshly prepared, carefully filtered, sealed in ampoules of alkali free glass, and sterilized by intermittent Pasteurization or Tyndalization. The solution must not be boiled. Old or improperly prepared solutions may give rise to severe secondary headaches, abducens palsy, or other sequelæ.

The needle employed is made of the iridio-platinum, and is seven centimeters long, not over one-tenth of a centimeter in thickness, with an obtusely beveled point not over one-fourth of a centimeter in length. It should have an accurately fitted stilet, and a ground beveled opening for affixing the syringe. (Fig. 1.) The syringe is of the Luer type, with a capacity of two cubic centimeters, graduated to one-tenth of a cubic centimeter. The syringe and the needle are to be wrapped in gauze and boiled in *distilled water* only, for ten minutes before using, or else sterilized in a cotton stoppered test tube in an autoclave. We prefer to have the syringe brought to

us in boiling water just before use, to guard its sterility and to insure a sufficient warming of the anæsthetic solution.

The average dose required for an adult is from one to one and one-fourth cc. of the solution, equivalent to four or five centigrams of stovaine. For an infant of one year, one and one-half centigrams (0.375 cc. of the solution) may be given; two centigrams for a child of three years; and three centigrams for a child of eight. Children with their active spinal centers withstand proportionately larger doses than adults. A relatively small dose should be used for the very aged, or for those with disease depressing or exhausting to the higher nerve centers. As the solution has a specific gravity of less than 1.000 and the cerebrospinal fluid a specific gravity of about 1.0065,[1] its lightness will cause this particular anæsthetic solution to rise rapidly within the cavity of the arachnoid. As an effect upon the higher nerve roots and centers is usually undesirable, the patient *should promptly have the head and shoulders lowered* after the injection. The anæsthetic is chiefly a *nerve root anæsthesia*, and not a true spinal cord anæsthesia, and if this precaution is not observed, undesirable blocking of the upper nerve roots (respiratory palsy) may be produced without anæsthesia of the area supplied by the lower spinal segments. For debilitated patients unable to breathe with the head lower than the body, this light solution must not be employed. In the chronologic order of their disappearance, there is loss of pain sense, loss of tactile and muscle sense, and finally motor paralysis. With high spinal anæsthesia, a tremendous fall of blood pressure and loss of consciousness may occur. The condition, therefore, may be properly termed anæsthesia and not merely analgesia, although analgesia and motor palsy, limited to the area of operation, are the chief effects desired by the surgeon.

Technique. The patient sits upon the operating table, the legs hanging over the side of the table. The head is well flexed upon the chest, the arms placed at the side, the forearms crossed over the groins, the back arched but only slightly inclined forward. (Fig. 2.) We asepticize the skin of the back by painting it with a five per cent solution of iodine crystals in acetone and apply a dry sterile dressing before the patient comes to the operating room. The patient being in position, the dressing is removed, the back flushed with alcohol and a sterile towel placed across the back with its upper edge upon the iliac crests. The

[1] Despite nearly 150 observations I am unable to confirm Jonnesco's assertion as to the variability of the specific gravity of the cerebrospinal fluid.

Fig. 1. Case for spinal anæsthesia, containing glass syringe of the Luer type with platino-iridium needle and a small needle for subcutaneous or intravenous injection. Besides the ampoules containing the anæsthetic solution, there is also an ampoule containing $^1/_{15}$ gr. of strychnine and 4 gr. of caffeine in solution for subcutaneous injection in case of respiratory depression, and another containing a 1 to 10,000 solution of adrenalin for intravenous injection in cardiac failure.

edge of a towel thus applied marks the position of the fourth lumbar spine or spinous interspace. Counting upward we select the first lumbar interspace for the injection if we are to operate upon the abdomen or lower thorax; the second interspace is preferable for operations upon the perineum or lower extremities, as I shall demonstrate to you later. If experienced, you can usually locate the spinous interspace by simple inspection. The needle is entered close to the middle of the interspace, not over two millimeters from the median line. If the needle enters the dura exactly on the median line the subdural plexus of veins may be punctured, causing a slight and apparently harmless but yet undesirable hæmorrhage. The needle is carried forward at right angles to the skin, and must not be inclined upward as has so often been advised. As soon as the resistent denseness of the ligamentum subflavum is encountered, the stilet is withdrawn and the needle pushed forward until the loose tissue external to the dura is entered. The needle is now more cautiously pushed forward, a few millimeters at a time, until the resistance and finally penetration of the dura is felt. The dura may puncture with an audible snap and there follows a flow of cerebrospinal fluid from the needle. If, in the introduction, the needle is not felt in the grasp of the dense ligament it is probable that you have deviated too far to the side; the needle, therefore, should be withdrawn and reintroduced. If the dura has been punctured the needle is cautiously rotated to make sure that the point is entirely within the cavity of the arachnoid. If no fluid escapes, the needle is moved slightly; the stilet is introduced and withdrawn, or a very gentle aspiration by the syringe

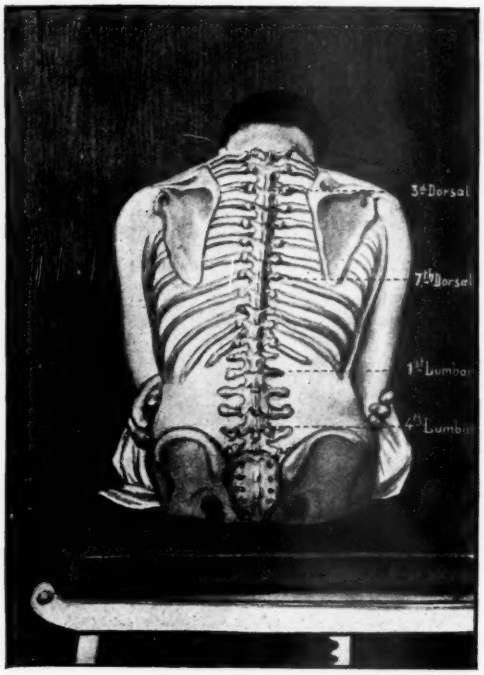

Fig. 2. *Spinal anæsthesia.* Position of the patient and method of localizing the spinal interspaces. The third dorsal interspace is opposite the spine of the scapula; the seventh opposite the angle of the scapula; the first lumbar interspace opposite the angle formed by the erector spinæ and the last rib, the fourth lumbar interspace opposite the crest of the ilium. The back should be well arched but not bent too far forward. The needle is to be introduced close to the median line near the middle of the interspace.

tried. If you still fail to obtain fluid, you should withdraw the needle, prove its patency, and try another interspace. A free flow of cerebrospinal fluid usually insures a satisfactory anæsthesia. Unless cerebrospinal fluid escapes from the needle, I have never obtained efficient anæsthesia. In only one case, this a patient with marked kyphosis, was I unable to introduce the needle between the lamina, but in two or three instances, although the needle entered the spinal canal, I have failed to obtain any cerebrospinal fluid, and in these patients the injection was followed by little or no evidence of analgesia. The needle having been properly introduced, the syringe containing the proper dose of warm solution is affixed, the piston cautiously withdrawn to prove a free communication with the spinal canal; and the solution gently introduced, withdrawing the piston slightly two or three times in the process to secure a better diffusion of the anæsthetic. On completing the introduction, the needle is quickly withdrawn and the patient immediately put in the recumbent posture. Apart from laying a sterile towel under the back, the small puncture requires no attention. Should a higher effect be desired the patient is kept upright after the withdrawal of the needle for from one-half to two and one-half minutes according to the height of the anæsthesia desired. While I have thus been able to operate successfully upon the neck, face and even the cranium, I do not advise you to employ this method as it involves greatly increased danger from interference with the phrenic nerve roots.

As for the lower spinal anæsthesia, I think you will observe that we are able to obtain a greater efficiency with less than half of the dose advised by Jonnesco. This is due to the fact that we secure a better diffusion by standardizing the specific gravity of the solution employed. Very weak patients may be anæsthetized while in the lateral position, the thighs and head being flexed upon the trunk. In any case we limit the diffusion of the anæsthetic upward by promptly lowering the shoulders. Should you desire the patient to be stupefied or unconscious during the operation, a hypodermic injection of one-sixth of a grain of morphia with one-hundredth of a grain of hyoscine or scopolamine may be given one hour, and also one-half hour before the time of operation. For obvious reasons most of the patients that we will show you during these clinics will thus have been narcotized. If no narcotic has been employed the eyes should be covered, and diverting conversation carried out by the assistant who watches the patient's pulse and respiration. In this way the operation may not infrequently be completed before the patient realizes that it has started. In no case should suggestive interrogations as to whether the patient is feeling pain be made.

The duration of the anæsthesia is from one-half hour to two hours, depending upon the method of administration and the dose employed. The preliminary use of narcotics prolongs the effect, probably by rendering the patient oblivious of returning tactile and pressure sense. In most cases spinal anæsthesia enables me to operate entirely free from the worry and watchfulness associated with etherization by an untrained assistant. From the higher spinal effects or from the mental impressions produced, nausea and vomiting may occur. This usually is very transient and is treated by lowering the upper part of the body.

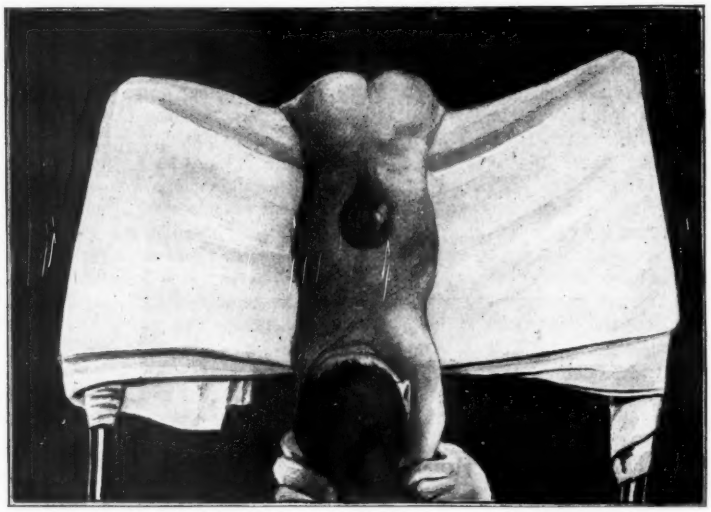

Fig. 3. *Operation for spina bifida.* Method of suspending the child for operation. This position prevents the loss of cerebrospinal fluid, reduces hæmorrhage, and is favorable to the employment of spinal anæsthesia by a fluid of low specific gravity.

For faintness, aromatic spirits of ammonia may be inhaled or administered. For thirst bits of cracked ice or water may be taken. For threatened respiratory depression, full doses of caffeine with strychnine are to be given by hypodermic injection. For cessation of respiration artificial respiration is to be carried out, preferably by rhythmic compression of the thorax, an assistant noting the air movements by a wisp of cotton placed over the nose and mouth. The lower jaw or tongue must of course be held well forward, and in some instances the intratracheal insufflation of oxygen as suggested by Meltzer, or forced artificial respiration, may be desirable. For cardiac failure, the intravenous introduction of 500 cc. of normal salt solution containing five minims of adrenalin is especially efficient; if this fails, cardiac massage should promptly be instituted. Efforts at resuscitation should not be abandoned until at least three-quarters of an hour has elapsed. *Death from spinal anæsthesia usually indicates inefficient or insufficiently prolonged methods of resuscitation.*[1] Fortunately, as a rule, none of these methods is required, but spinal anæsthesia is so often selected for patients in a desperate and nearly moribund state, that all of these resources should be quickly available.

The after treatment of spinal anæsthesia requires little consideration. Of itself the anæsthetic does not contraindicate the early administration of food. The patient should remain recumbent for one hour after the anæsthetic has been used. Secondary headaches are treated by keeping the head low and applying ice caps. If severe or frequent they indicate a technical error or the employment of decomposed solutions. I have seen no case of ocular palsy since we have been using freshly prepared solutions.

NARCOTIC ANÆSTHESIA

While spinal anæsthesia is preferred for operations involving the lower part of the body, we prefer narcotic anæsthesia for many operations involving the head, neck and upper respiratory passages. The method is not available in young patients, but may usually be employed in patients over thirty-five. Senility and debilitated conditions increase the susceptibility. Many years ago we observed in acute alcoholism that the subcutaneous injection of apomorphine produced narcosis with anæsthesia, and at the present time we consider apomorphine one of the most powerful adjuvants to narcotic anæsthesia. If you will employ it, you will better realize how criminal is the text-book direction that

[1] I have resuscitated a patient after cessation of heart action for over twenty minutes, and cessation of spontaneous respiration for over thirty minutes. Let no surgeon who operates upon patients in extremis believe in that heresy of the lawyers and pathologists, *somatic death.* There is but one death: "molecular death."

apomorphine be used as an emetic in narcotic poisoning.

We vary the dosage and the drugs employed according to the individual's susceptibility, the general method being as follows: About one hour and a half before the time of operation, the patient receives a hypodermic injection of one-sixth of a grain of morphine with one-hundredth of a grain of hyoscine or scopolamine. Shortly after this there is run into the bowel an enema containing one ounce of alcohol and one ounce of compound spirits of ether in five ounces of normal saline solution. Twenty minutes after the first hypodermic injection the patient's condition is studied. Usually there is some drowsiness but no marked narcosis; this being the case the hypodermic injection is repeated. The patient is now continuously watched, and twenty minutes later a third hypodermic may be given, dependent upon the patient's individual requirements. If the patient be profoundly asleep, insensible to painful impressions, no other injection is given. If the skin be red and hot, the pulse full and rapid, and the pupils somewhat dilated, and the patient perhaps slightly delirious, it is evident that sufficient hyoscine has been given, and that more morphine, and especially apomorphine, are desirable to complete the narcosis. If the pupils are found to be small, the pulse and respiration slow, the surface not reddened and the patient roused with difficulty but still moving, on the production of painful impressions, no further dose of morphine is necessary but an additional dose of scopolamine, possibly reinforced, unless the patient be almost narcotized, by a small quantity of apomorphine. In many instances the patient is so readily aroused that the injection of one-sixth of a grain of morphine and one-hundredth of a grain of scopolamine is repeated for the third time and there is added from one-twelfth to one-twenty-fifth of a grain of apomorphine. The apomorphine is especially powerful and must be used with caution. Yet in the very robust even one-tenth of a grain may be employed. If attempts at emesis follow the injection of apomorphine they are almost invariably slight and inefficient, and profound narcosis may come on suddenly in from three to ten minutes after the injection containing the apomorphine. For more resistent patients, it may be found twenty minutes after the third injection that a fourth is required, which is to be selected according to the particular requirement of the patient. This we may term narcosis by the "drop method." Feeble old men may be narcotized by a single injection; a robust, middle-aged patient with great vitality may require four or five injections. In any case, the patient is to be watched as carefully as if ether were being administered, and with the onset of the narcosis the respiratory passages must be kept free. You must remember that respiratory movements do not prove the continuance of respiration, and that these patients may have the tongue fall back and may suffocate while the attendant watches what appears to be a labored form of respiration and gives the patient hypodermics for eventually failing heart and respiratory action. A wisp of cotton over the mouth and nose is a useful indicator. One of my patients was permitted to suffocate and several have been rescued when in great peril because our residents have failed from time to time to heed the repeated admonition to "keep the upper respiratory passages open and upon the slightest evidence of danger pull the lower jaw or the tongue forward." The anæsthesia lasts from two to six hours and the patient usually awakens protesting that no operation has been done and that he has not even been asleep. A number of patients who have experienced etherization, as well as this form of narcotism, have asserted that the secondary depression is less than after the ether anæsthesia. In one instance we narcotized a patient in her home, had her brought to the hospital, removed a carcinoma of the parotid, and the patient awoke during the following night in her own bed, not realizing that she had left her house, or that an operation had been done. In conditions of alcoholic mania, nervous excitation, and morbid fear of operation, we have been enabled by this narcosis to surreptitiously anæsthetize the patient. From the patient's viewpoint, the method is ideal. The dry throat and preservation of some of the reflexes render it a splendid method in extensive operations about the mouth, larynx, face and skull. For subtentorial tumors, where the danger of sudden death is always great, it should not be employed. I have used it with the greatest satisfaction in operating upon the upper spinal nerve roots. Here is a method, therefore, which enables one to dispense with inhalation-anæsthesia and that may be applied in certain cases with great comfort to the patient. After the operation we usually aid elimination by administering an enema of one or two quarts of salt solution, to which is often added a pint of hot coffee with a dram of tincture of capsicum. In some instances in order to combat excessive narcosis the subcutaneous use of caffeine and strychnia have been employed. As we better understand the methods of maintaining the respiratory function, we lose much of our fear of opium poisoning.

To better illustrate the practical technique of these methods of anæsthesia, we have included a brief clinical summary of all of the important cases presented before the Congress, indicating the amount of anæsthetic employed, the delay incident to arranging the patient for the operative procedure, the duration of the operation and any special untoward effects observed. To this in each case has been added a brief summary of any unpleasant post-operative symptoms. As a rule, no reference has been made to wound healing, for fortunately, despite the crowding of the amphitheatre and the operating space, no wound infection occurred from any operation [1] done before the Congress. There was no collapse or serious operative complication, and no death resulted from any of the operations. One patient, a very old man, however, died five weeks later from progressive senile changes, his life apparently having been prolonged as a result of the operation. There is, therefore, nothing to indicate that any patient suffered the slightest physical detriment for having been operated upon before the Congress.

In the description of the cases, it is, of course, not feasible in this article to include any but the briefest discussion.

November 8, 1911

CASE 1. *Spina bifida. Osteoplastic closure.* John G., Coaldale, Pennsylvania. Six weeks old. Lumbosacral meningomyelocele, with small sac involving three laminæ. Head dependent suspension. (Fig. 3.) Anæsthesia. Paregoric 15 minims by mouth one-half hour before operation. Stovaine 1¾ cg. into the sac. Resection of sac, replacement of cauda equina, plastic closure of pia arachnoid and dura, the edges of laminæ loosened, suture of aponeurosis and muscle over defect,[2] transverse suture of the skin with fine horse-hair. Deep sutures of 0 and 00 catgut. Operation was started four minutes after spinal injection. Duration of operation nineteen minutes. (Secondary symptoms, some necrosis along the line of skin incision, reactionary temperature of 104 after forty-eight hours. Patient discharged on the eighth day. Reported strong and well July 12, 1912).

CASE 2. *Acute interstitial appendicitis. Incomplete inguinal hernia. Appendectomy. Inversion and suture of hernial sac through appendiceal wound.* Samuel T. Age 53. Tin roofer. Paralysis of right arm and leg twenty years ago; three distinct strokes. Later necrosis of costal cartilage of the second rib followed by inflammatory rheumatism. Ten years ago passed five vesical calculi. For the past six weeks intermittent colic in the right inguinal region associated with constipation. Continuous for the last twenty-four hours. Slight rigidity of the right lower rectus, tenderness of McBurney's point. Anæsthesia, stovaine 4½ cg. in the first lumbar interspace. Operation started five minutes after intradural injection. One and one-half inch incision in the line of skin cleavage with McBurney separation of abdominal layers. Acute interstitial appendicitis. Appendectomy. Exploration of the right iliac region disclosing incomplete right inguinal hernia with thick-walled sac. Body of sac grasped with forceps passing through the appendiceal incision, the sac inverted into the abdomen and sutured to the abdominal wall below incision. (Fig. 4.) Closure of the single wound in five layers, by imbrication with number one chromic catgut, and buried suture of the subcutaneous fat and skin by number one plain catgut. Duration of operation eighteen minutes. (Secondary symptoms absent. Discharged eleven days after admission.)

Fig. 4. *Inversion of a hernial sac* through a small appendiceal incision. The incomplete inguinal hernia was revealed by the exploring finger, the hæmostatic forceps guided to the bottom of the sac which is here shown grasped and partially inverted. The inverted sac was sutured to the inner surface of the abdominal wall through the incision.

CASE 3. *Repeated miscarriages following bisection of uterus for vaginal myomectomy. Plastic operation on cervix and perineum.* Mrs. Lena R. Age 32. Russian. Difficult instrumental delivery with lacerations seven years ago. Three years ago I split the anterior wall, the fundus and most of the posterior wall of the uterus through the vagina and enucleated a fibroid tumor of the posterior wall the size of an egg. The two halves of the uterus were sutured together through the vagina with catgut. Following this operation two miscarriages at five and six months occurred. There is an anterior cleft of the cervix, and the remains of the two old lateral lacerations, and a moderate relaxation

[1] The limited tissue necrosis in the case of spina bifida we have found to be almost invariable after operations for meningomyelocele and is hardly to be classed as an operative infection.

[2] "Spina Bifida and its Surgical Treatment, with a Description of an Efficient Osteoplastic Operation." Monthly Cyclopedia and Medical Bulletin, May, 1911.

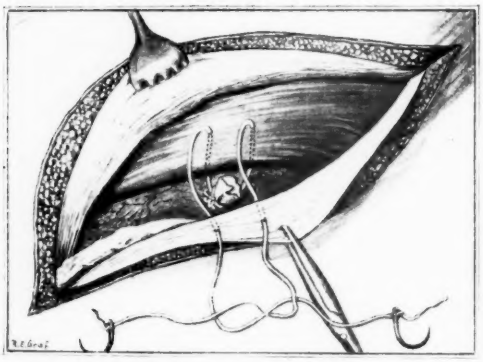

Fig. 5. *Inguinal herniotomy by a single suture.* The neck of the sac has been transfixed and tied by a long strand of number one or two catgut, to each end of which a needle is tied. Using the blunt ends of the needles as in Halsted's method, the internal oblique and transversalis are transfixed from behind; the two suture ends then catch the corresponding areas of the shelving part of Poupart's ligament. On tying the suture, the neck of the sac is transplanted to a higher level behind the deep muscles, and the muscles are pulled down to Poupart's ligament tending to fill and obliterate the inguinal canal. The neck of the sac is therefore not only supported by the deep muscles but also by Poupart's ligament.

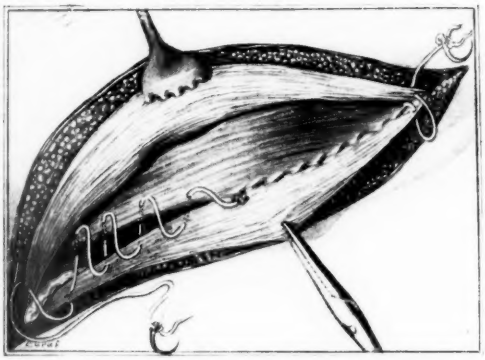

Fig. 6. *Herniotomy in a single suture.* The ends of the suture have been tied transplanting the neck of the sac and rolling the thick muscular belly of the internal oblique and transversalis under Poupart's ligament thus filling the canal. Proceeding from the central point of ligation the two suture ends are now used to complete the approximation of the shelving portion of Poupart's ligament to the internal oblique, transversalis and conjoined tendon. The sutures are finally brought through the layers of the internal oblique in such a manner as to imbricate the edges of this aponeurosis.

of the outlet with some rectocele. Anæsthesia, two injections of morphine ⅙ gr.; scopolamine, 1-100 gr. Spinal anæsthesia, by 4 cg. of stovaine in the first lumbar interspace. Operations started five minutes after intradural injection. Plastic operation upon the cervix, correcting the median and lateral lacerations, submucous perineorrhaphy with buried fine chromic [1] and plain catgut. Duration of operations and demonstration thirty minutes. (Secondary symptoms, patient vomited once. Moderate headache second to fourth days. Permitted to be out of bed ten days after operation. Discharged two weeks after operation. Patient in excellent condition three months later.)

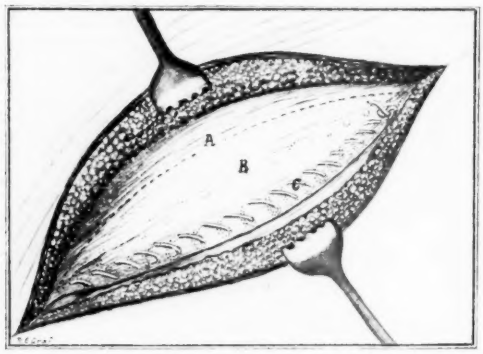

Fig. 7. *Inguinal herniotomy continued.* The upper edge of the aponeurosis of the external oblique is pulled well down over Poupart's ligament, the edge of which is indicated by the dotted line at (A), and the longer suture end continued as indicated at (C), completing the imbrication by uniting the aponeurosis of the external oblique to the cleared fascia-Lata. The ends of the single suture are finally tied. The deeper sutures are indicated by the dotted lines (B). If necessary, a few reinforcing individual sutures are also applied before the closing of the skin and subcutaneous tissues.

CASE 4. *Cholelithiasis and cholecystitis with subacute perforation of gall bladder. Heart and kidney disease. Cholelithotomy and cholecystostomy.* Mrs. Matilda F. Age 46. American. Has had indigestion, bloating, belching and other forms of gastric disturbance for years. Two months ago an attack of bilateral lower abdominal inflammation lasting four days with tenderness since. A month ago severe attacks of pain in the right hypochondrium associated with vomiting, fever, rigidity of upper right rectus, and tenderness over gall-bladder, confining the patient to bed for three weeks. Tenderness has continued since. There is no jaundice, but an intermittent pulse, a mitral-systolic murmur, an accentuated aortic second sound; and the urine contains albumin and granular casts, and a few red blood corpuscles. Leucocytosis 9400. Two preliminary injections of morphine ⅙ gr.; scopolamine 1-100 gr. Spinal anæsthesia by 4½ cg. of stovaine in the first lumbar interspace. Operation started four minutes after the intradural injection. Upper right rectus incision, gall-bladder found to be adherent and perforated. Six gall-stones removed. Large drainage tube inserted, with inverting purse string sutures, gall-bladder anchored to abdominal wall, and cigarette drain placed in the wound down to sutured gall-bladder. Wound closed in layers by catgut, with continuous fine Pagenstecher suture for the skin. Pulse 100, respirations 16, before operation; 96 and 26 after operation. Duration of operation sixteen minutes. (Secondary symptoms, pulse irregular part of

[1] Babcock, "Submucous Perineorrhaphy," Jour. A. M. A., May 15th, 1909.

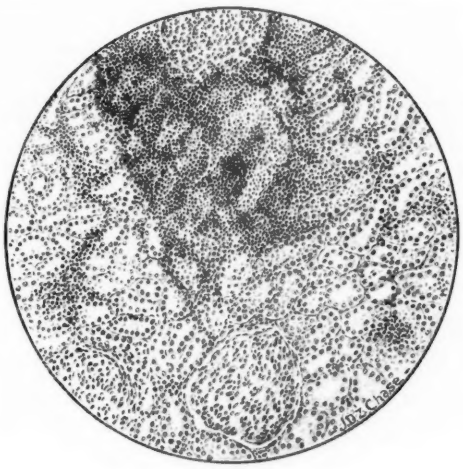

Fig. 8. Showing the diffuse infiltration of round cells in the right kidney. No giant cells were present, although certain of the infiltrated areas had central coagulation necrosis. The condition is probably a diffuse miliary tuberculosis of the kidney.

the first night. Vomited four times first thirty-six hours. Patient permitted to be out of bed twelve days after operation. Urinary bladder irrigated for cystitis. Discharged, twenty-two days after operation; cured.)

CASE 5. *Indirect inguinal hernia. Herniotomy.* Yalkan G. Italian laborer. Twenty-seven years old. Ten months ago incomplete inguinal hernia first noticed on arising. A truss has been found unsatisfactory. Anæsthesia, stovaine, 4½ cg. in the first lumbar interspace preceded by two injections of ⅙ of a grain of morphine and 1/100 grain of scopolamine. Operation started one minute after intradural injection. Radical herniotomy with transplantation of neck of sac and imbrication of muscular and fascial layers. (Figs. 5, 6, and 7.) Deep sutures of number one chromic catgut with subcuticular and fascial suture of buried number one plain catgut. Pulse 80, respiration 20 before operation; pulse 90, respiration 16 after operation. Duration of operation fourteen minutes. (Secondary symptoms, the patient vomited once. Primary union. Discharged on the fourteenth day.)

CASE 6. *Inguinal ectopy of the right testicle. Transplantation of testicle. Herniotomy. Appendectomy.* Hyman L. Age 7. School boy. Right testicle has occupied the inguinal canal since birth. Enlarged inguinal rings. Enuresis. Anæsthesia, morphine 1/12 gr. one-half hour before operation. Intradural injection of 3 cg. of stovaine solution in first dorsal interspace. Operation, testicle freed and transplanted to the scrotum. Peritoneum opened through the internal ring and appendix removed with inversion of the stump. Peritoneal opening sutured, transplanted and radical herniotomy performed by the method of imbrication as elsewhere described. Operation started five minutes after intradural injection. Deep sutures of chromic number one catgut. Duration of operations fourteen minutes. (Post-operative symptoms, vomited once the first night only. Permitted out of bed twelve days after operation. Primary union. Discharged sixteen days after operation. Cured.)

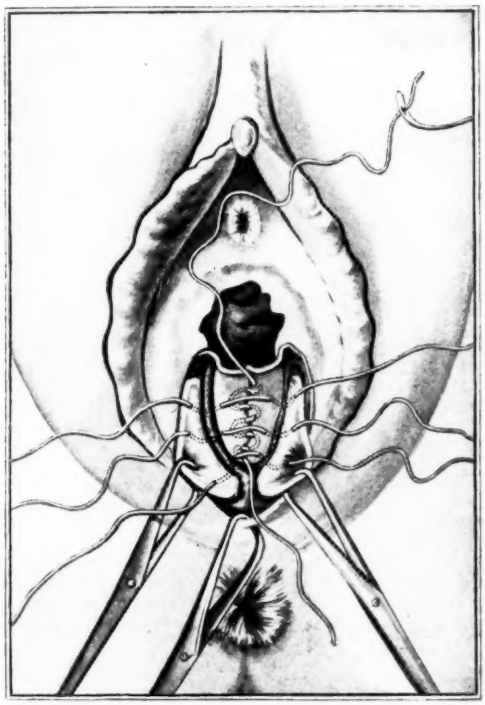

Fig. 9. *Author's method of submucous perineorrhaphy.* This figure is introduced to emphasize the importance of suturing the recto-vesical fascia and the inner surfaces of the levator ani where a strong support is required. The transverse incision has been made and the posterior vaginal wall built anteriorly by a continuous submucous suture. Three transverse sutures are represented which catch the deep internal surfaces of the muscle, the rectovesical fascia, and parts of the submucous wall. After these sutures are tied the muscular edges are then united, after which the external fascial, aponeurotic and skin layers are brought together in the usual manner.

November 9, 1911

CASE 7. *Trifacial neuralgia. Second branch. Injection of osmic acid.* Miss Matilda H. Age 45. Has been ill and nervous for nine years. Right proptosis since the age of fourteen. Sharp lancinating pains at the inner canthus of right eye, cheek and right side of the nose for nine months, increased by recumbency and almost constant for the past seven weeks. Narcosis. Morphine ⅙ gr. two doses; scopolamine, 1/100 gr., two doses; apomorphine, 1/20 gr., one injection; with preliminary enema of compound spirits of ether and spiritus frumenti. Narcosis reinforced by two ounces of ether. Operation, mouth retracted exposing reflection of buccal mucous membrane above the right cuspid. Incision, two centimeters long through the line of mucous membrane reflection. Retraction and separa-

Fig. 10. Recently healed stump made by the nearly obsolete method of transfixion. It is believed that this method should be revived for those amputations where the vitality of the flaps is in question, or where a minimum of traumatism and tissue handling is important.

Fig. 11. *Amputation of Celsus* advocated in the treatment of certain spreading infections. The absence of flaps facilitates drainage and permits topical applications and the inspection of the stump, and the method is especially advocated in those cases in which a higher amputation with the formation of flaps would be a dangerous and probably fatal procedure.

tion of tissues from the superior maxilla exposing the infraorbital foramen. Infraorbital nerve demonstrated, wound isolated by gauze, and nerve trunk and foramen injected by a fine hypodermic needle with approximately a two per cent of freshly prepared osmic acid solution. Mucous membrane sutured. Duration of operation seven minutes. (Secondary symptoms, post-operative soreness and pain n the jaw which gradually decreased. Patient discharged eight days after operation. Reported March, 1912, as free from the tic douloureux.)

Fig. 12. Showing the degree of spontaneous wound closure about three months after amputation of Celsus for gangrene due to the bacillus ærogenes capsulatus.

CASE 8. *Cystic adenoma of mammary gland. Plastic resection of gland.* Mrs. T. Age 32. American. Movable mass in the upper, outer quadrant of the mammary gland for the past six months. At times painful. Preliminary narcosis, two hypodermic injections of morphine $\frac{1}{6}$ gr., scopolamine $\frac{1}{100}$ gr., and enema containing one-half ounce of compound spirits of ether, one-half ounce of spiritus frumenti. Stovaine 4½ cg. injected through the twelfth dorsal interspace. Patient permitted to sit up three-quarters of a minute to secure analgesia of the upper dorsal segments. Operation started four minutes after intradural injection. Semi-circular incision about the outer and lower border of the breast. Mammary gland separated from the chest, everted and wedged shaped excision of the breast tissue including the growth made from the under surface. Cystic adenoma. Closure without drainage by deep and subcuticular suture of plain number one catgut. Duration of operation, ten minutes. (Secondary symptoms, patient vomited once the first night. Some headache, ringing in the ears, pains in the back of the neck on the second day, continuing until the fifth day. Largely relieved by re cumbency. Primary union.)

CASE 9. *Miliary tuberculosis of kidney. Nephrectomy. Recurrence in opposite kidney. Decapsulation and cortical incisions. Recovery.* Mrs. Y. Age 42. Family history negative. Previous history of scarlet fever, measles, mumps and pertussus in childhood. General health excellent since. Present illness began weeks ago, with painful, frequent micturition, followed by chills and fever and tenderness over McBurney's region. Examination showed the right kidney very tender and three times the normal size. Urine contained pus and pus casts. Right lateral nephrectomy twenty-seven days ago. Removed kidney was studded with miliary abscess-like areas from which only staphylococci grew (Fig. 8.) After temporary im-

provement, increasing remittent temperature developed with chills. Pyuria continued; on catheterization of the left ureter, pus casts and pus clusters were found. The patient is very anæmic and weak. Second operation, stovaine 4½ cg. in the first lumbar interspace. One hypodermic injection of ⅙ gr. of morphine and 1/100 gr. of scopolamine preceded the stovaine. Operation started five minutes after intradural injection. Oblique left lumbar incision with exposure of the kidney. Decapsulation and superficial renal scarification. Kidney injected and surface sprinkled with minute grayish points suggesting miliary tubercles. Suture of the muscular, fascial and skin layers without drainage. Deep catgut sutures with button hole suture of the skin with celluloid linen. Duration of operation thirteen minutes. Pulse 90, respirations 24, before operation; 80 and 20 after operation. (Secondary symptoms, patient vomited three times first night. Urinary output about 29 ounces the first day; 56 the second; 72 the fourth and 90 ounces the sixth day. Rapid improvement with practically normal temperature after the fifth day. Combined vaccines started on the eleventh day. Primary union. Patient discharged twenty-five days after the second operation. Reported "well" March, 1912.)

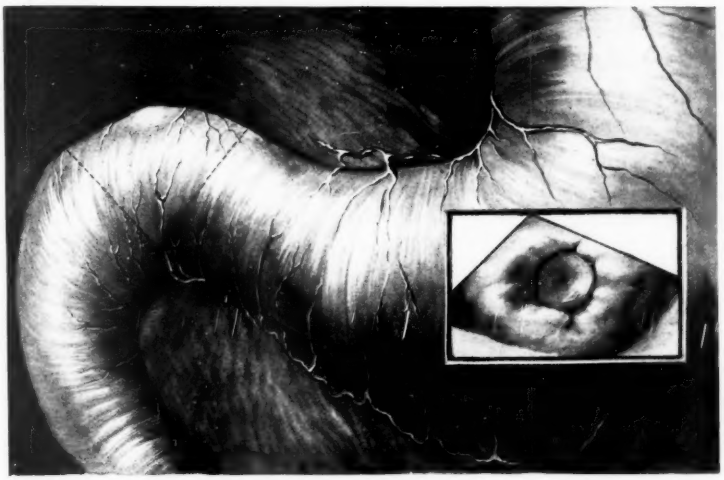

Fig. 13. Case 20. *Sclerotic ulcer* situated upon the pyloric ring. Dotted lines indicate the wedge-shaped area of resection. A narrow strip of the posterior pyloric wall was left. The smaller picture illustrates the mucous surface of the excised ulcer.

Case 10. *Eight operations for divers conditions.* Mrs. Anna S. Age 41. Russian. Multipara. Had an operation for intra-abdominal abscess after confinement eighteen years ago. Ill for six years. Has ventral hernia, chronic inflammation of appendages and laceration of cervix and perineum and gall-stones. Anæsthetic, 4 cg. of stovaine in the first lumbar interspace preceded by two injections of ⅙ gr. of morphine, and 1/100 gr. of scopolamine. Abdominal operation started five minutes after intradural injection. Resection of abdominal scar and hernial sac; resection of adherent omentum, salpingo-oöphorectomy; appendectomy; separation of adhesions. Removal of gall-stones; cholecystostomy. Suture of recti, imbrication of aponeurosis. Duration of abdominal operations forty minutes. Trachelorrhaphy and submucous perineorrhaphy. (Fig. 9.) Duration of plastic operations fifteen minutes. Pulse 88, respirations 20, before operations; 82 and 20 after operation. (Secondary symptoms, the patient vomited twice in the first twenty-four hours only. Tube removed from the gall-bladder on thirteenth day. Primary union of all incisions except at point of biliary

Fig. 14. Case 20. Suture of the pyloric end of the stomach by continuous sutures, in two layers after excision of the ulcer and adjacent pyloric wall. The enlargement of the pyloric ring by the method of suturing is indicated.

Fig. 15. *Lipectomy*, indicating the lines of incision in resecting the obese and pendulous abdominal wall. The fat is stripped from the aponeurosis and by undermining, is resected for a number of inches in all directions beyond the line of incision. After resecting the main mass and reconstructing the aponeurotic and muscular layers of the abdominal walls, it is at times desirable to remove ellipses of skin and fat from over the hips. Over fourteen pounds of fat were removed from the patient of whom this picture was made.

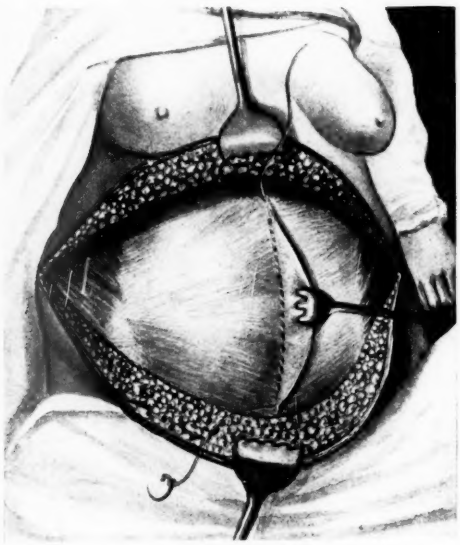

Fig. 16. *Lipectomy continued.* The transverse ellipse of skin with a mass of subcutaneous fat has been removed. A median incision has been made and the hernial sac excised. The left edge of the deep abdominal wall is retracted and the right edge sutured well under this by continuous suture of number one or number two chromicized catgut.

drainage. Patient discharged on the twenty-eighth day. Cured.)

November 11, 1911

CASE 11. *Tabes mesenterica. Chronic appendicitis. Lymphadenectomy. Appendectomy.* Henzel B. Age 18. German, baker. Has been ill for several days, with abdominal colic followed by nausea, vomiting, obstipation and pain and tenderness in the right lower quadrant of the abdomen. Operation one and one-half hours after admission. Stovaine 4 cg. in the first lumbar interspace without narcotic. Operation started five minutes after the intradural injection. One and one-half inch transverse incision internal to the right anterior iliac spine. McBurney separation to peritoneum. Moderate serous intra-abdominal effusion; general enlargement of mesenteric glands. No pus. Appendectomy. Removal of mesenteric gland for diagnosis. (Tabes mesenterica.) Duration of operation nineteen minutes; pulse 96, respirations 20, before operation; 88 and 18 after operation. (Secondary symptoms, some tympany on the second day. No vomiting. Primary union. Out of bed on the ninth day; discharged on the fourteenth day.)

CASE 12. *Senile gangrene of leg. Amputation through the thigh by transfixion. Recurrence of gangrene. Uremia. death.* Mr. E. M. H. Age 71. American. Retired. Paternal history of tuberculosis and of paternal kidney disease. Patient had typhoid at 15; chancre at 21; Neisserian infection at 30. Marked arteriosclerosis and atheroma. Slight albuminuria. Senile gangrene of the right foot beginning two months ago after abrasion from a shoe. Ineffectively treated for two weeks in the hospital by active hyperemia and other measures. Anæsthesia, one injection of morphine, ⅙ gr.; scopolamine, 1/100 gr.; digitalin 1/10 gr.; stovaine 4 cg. in the second lumbar interspace. Operation started six minutes after intradural injection. Amputation of the lower third of thigh by transfixion. Tube drain. Duration of operation ten minutes. Pulse 80, respiration 20, before operation; 128 and 14 after operation. (Secondary symptoms, no vomiting, catheterized once. Primary adhesion followed by secondary progressive gangrene of the stump. Later involuntary dejections, formation of bed sores. Patient kept out of bed part of the time. Death from progressive toxæmia and uræmia five weeks after operation.)

The usefulness of obsolete operations. In amputating for gangrene, we have revived the obsolete method of transfixion. This method not only makes the operation more expeditious but avoids a separation of tissue layers and insures the minimum handling and manipulation so desirable when dealing with tissues that are so devitalized and with vessels that are very atheromatous. As you observe, two strokes of the knife separate the soft tissues and a few seconds later the saw has removed the limb. Bunge has shown us the advantage of having no periosteum about the end of the bone. The vessels are tied, the soft wide tourniquet which has been used to avoid

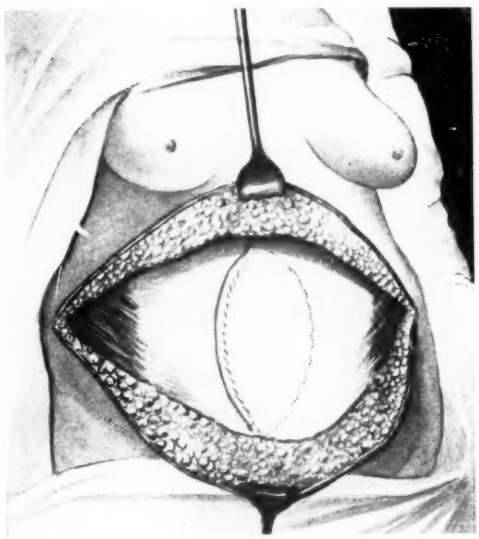

Fig. 17. *Lipectomy continued.* Restoration of the pendulous abdominal wall. The underlying imbricating suture has been completed and is here indicated by a fine dotted line. The left wound edge has been pulled well to the right and fastened by a continuous suture of chromic catgut to the underlying aponeurosis completing the broad layer imbrication. In this way the internal edges of the separated recti muscles are brought to the median line and given an added aponeurotic sheath. Care must be taken not to unduly reduce the abdominal capacity.

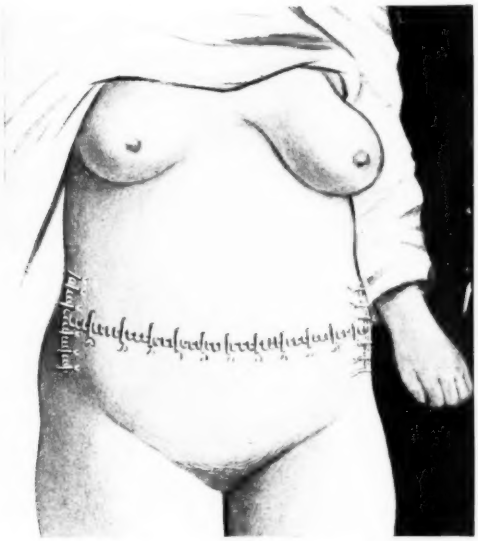

Fig. 18. *Lipectomy.* Indicating the approximated incisions after reconstruction of the abdominal walls. Deep figure 8 sutures of silk worm gut are employed with approximating button hole suture of the wound edges by fine celluloid linen. Despite the enormous wound area, drainage is unnecessary and thus far we have had no suppuration.

bruising is removed, the divided muscles and superficial tissues approximate more readily than is usual after amputation by layer method, and the operation is completed with a minimum of traumatism. The stump is symmetrical and the late appearance of such a stump made by transfixion is shown in this photographic enlargement (Fig. 10). We also have revived, as a helpful surgical measure, the most ancient known method of amputation, that of Celsus, in which the limb is cut off as by a single stroke, without the formation of any flap. (Fig. 11.) The use of this method may be life saving in certain spreading infections, particularly emphysematous gangrene.

This, for example, is the photograph (Fig. 12), of a young man whose life was apparently saved by this method. Although the attending surgeon declined to reoperate, considering the patient beyond hope, he kindly permitted me to amputate under spinal anæsthesia. The patient was delirious, in collapse, and apparently about to die from a recurrent and rapidly spreading infection by the bacillus ærogenes capsulatus. The transverse amputation was followed by the application of a solution of iodine with balsam of Peru to the stump. The open stump permitted the prompt recognition and excision of a focus of recurrent emphysema. The picture shows the degree of spontaneous closure about two months after the operation, all the tissues being covered but the granulating bone end, which was later excised.

Case 13. *Simulated intestinal obstruction in a neurotic and leutic young woman. Adhesions. Jackson's membrane and Lane's kink. Ileosigmoidostomy.* Miss Sarah B. Age 21. German. Congenital lues. Has suffered from various neuroses for years, for which many abdominal operations have been performed. The patient has just been admitted to the hospital for acute intestinal obstruction. The history is of abdominal pain for three weeks with severe and repeated vomiting for four days with inability to move the bowels, despite very active medical treatment at home. Dangerous obstruction doubted in view of the patient's previous history.

Exploratory operation. Anæsthesia, morphine ¼ grain; scopolamine, 1/100 grain, one hour before operation. Stovaine 4½ cg. through the second lumbar interspace. Operation started six minutes after intradural injection. Vertical incision about four inches long through the right rectus. Exploration of the abdominal cavity revealing adhesions from previous operations, V-shaped loop of transverse colon, redundant sigmoid flexure, Jackson's membrane over the upper two-thirds of the ascending

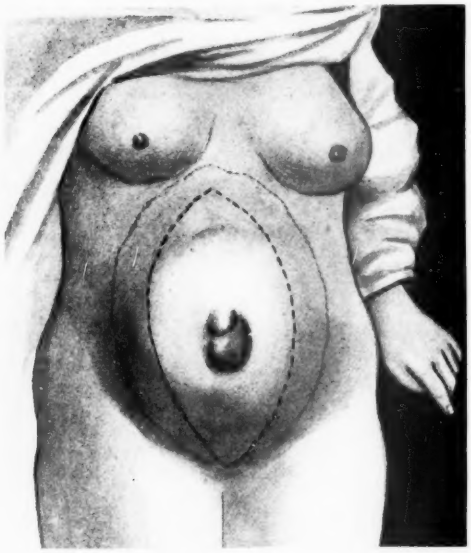

Fig. 19. *Lipectomy.* Vertical excision of an ellipse of the anterior abdominal wall and subcutaneous fat. Occasionally used for the obese and relaxed abdominal wall where there is not the usual overhanging of the tissues upon the thighs. Faint dotted lines suggest the undermining for the removal of the subcutaneous adipose tissue.

colon, Lane's kink at the terminal portion of the ileum of moderate degree. No marked intestinal obstruction. Separation of Jackson's membrane; division of adhesions, over Lane's kink, lateral anastomosis by two layers of suture between lower ileum and the sigmoid. Duration of operation thirty-eight minutes. (Secondary symptoms, slight vomiting the first few days. Urine voided, although the patient had been unable to do this previous to operation. Out of bed on the twentieth day. Following this the patient developed hysterical attacks and refused to void urine except at long intervals. Later the patient insisted upon being catheterized and as she became weak and emaciated and refused to eat, nasal feeding was employed. This was followed by improvement and resumption of feeding. The patient presented a constant series of neurotic symptoms. She has been much less constipated since the operation. The patient did not desire to return home but finally was discharged, fifty-seven days after admission. Primary union.)

CASE 14. *Tuberculosis of os calcis and astragalus. Partial resection and use of Mosetig-Moorhof wax. Recovery.* Anthony D. Age 20. Italian laborer. Mother tuberculous. Cervical adenitis ten years ago. Pain in the left ankle began three years ago but patient was able to work until four months ago. Constant dull pain with sharp exacerbations, worse at night, and after exertion, with increasing swelling. Has previously been in the hospital, and has also been treated in an orthopœdic dispensary and by Schaffer vaccine without benefit. Has lost twenty pounds. Ankle is markedly swollen and tender. Anæsthesia, morphine 1/6 gr., and 1/4 gr. on the operating table. Spinal anæsthesia, about 4 cg. of stovaine in the first lumbar interspace. Operation started seven minutes after intradural injection. Some retention of tactile sensibility. External hook incision of Kocher. Peronei tendons divided at different levels, foot dislocated inward, freely exposing the ankle joint. Resection of necrotic portions of astragalus and os calcis and removal of infiltrated synovial membrane. Cavity dried and filled with Mosetig-Moorhof wax. Replacement of foot, suture of divided ligaments, and peronei tendons with fine chromic catgut. Continuous button hole suture of the skin with celluloid linen. No drain. Duration of operation thirty-three minutes. Immobilization. Pulse 84 and respiration 20 before operation; 88 and 18 after operation. (Secondary symptoms, moderate headache for forty-eight hours. Permitted out of bed eight days after operation; discharged on crutches nine days after operation. In March, 1912, reported that he had been walking and working for several weeks without discomfort. Joint only slightly enlarged and not ankylosed.)

CASE 15. *Chronic goneitis from loose semi-lunar cartilage. Hyperplastic synovial fringes. Arthrotomy.* Mrs. Alice T. Age 47. English. Married. One child. No miscarriage. Wasserman negative. One brother died of tuberculosis. Double oöphorectomy eighteen years ago. Nineteen years ago, while working the pedal of a straw hat making machine a stabbing pain suddenly developed in the inner side of the left knee causing the knee to become stiff and preventing work. Paroxysms of pain came frequently during the next six weeks lasting from one-quarter to three-quarters of an hour both during the night and during the day, the knee always being in extension. Relief, except for paresthesia and weakness, followed until three years ago when constant neuralgic pain with intense hyperesthesia of the knee developed, which was greatly aggravated by working and was often worse at night. Ineffectually treated by fixation for six months, baking, Bier treatment, and one year ago by drilling the head of the tibia. Locally there is only a slight swelling and no evidence of deformity. Operation. Anæsthesia, two injections of morphine 1/6 grain; scopolamine 1/100 grain; spinal injection, 4 cg. of stovaine in the first interspace. Operation started three minutes after intradural injection. Knee joint freely opened by external hook incision by Kocher. Removal of swollen *synovial fringes* and of loose semilunar cartilages. Suture of synovial membrane, the obliquely divided patellar ligament, and the lateral ligaments with chromic catgut. Continuous button hole suture of the skin with fine celluloid linen. Duration of operation twenty minutes. Plaster cast. (Post-operative symptoms, no nausea or vomiting, no urinary retention, or headache. Convalescence retarded by sore back. Patient relieved from the old pain in the knee from the first. Primary union without ankylosis, immobilization continued for about seven weeks. Patient discharged fifty-nine days after operation.)

CASE 16. *Lacerated and contused wounds. Resection of devitalized tissue over patella. Suture.* Mr. Francis T. Age 24. American. Fireman. The patient has recently been struck by an engine, sustaining lacerated and contused wounds of the head and of the right knee. Anæsthetic, stovaine 4½ cg. in the first lumbar interspace preceded by subcutaneous injection of 1/4 gr. of morphine. Operation six minutes after intradural injection, consisting of resection of contused and lacerated tissues over the right patella with deep and superficial closure by catgut. Duration of operation five minutes. Pulse 66, respiration 24 before operation; 56 and 18 after operation. (Secondary symptoms absent. The patient insisted on returning home on the fourth day.)

CASE 17. *Necrosis of os calcis following crush. Sequestrotomy.* Annie D. Age 14. Office work. Two months ago heel was crushed in an elevator, fracturing calcaneum and avulsing the soft tissues. Two discharging sinuses have persisted since. Anæsthetic, morphine ⅙ gr. by hypodermic injection. Stovaine, 3¼ cg. in the second lumbar interspace. Operation started three minutes after intradural injection. Sequestrum of os calcis removed and drain introduced. Duration of operation nine minutes. (Secondary symptoms absent, except slight headache. Permitted out of bed three days after operation. Discharged thirty-one days after operation.)

CASE 18. *Right sided abdomino-pelvic abscess. Exploratory celiotomy. Vaginal drainage.* Miss Rose B. Age 34. American. Home duties. Walked into the dispensary and said she had been ill one week, and that her bowels had not been moved for five days. Burning pain and tenderness in the abdomen one-half inch below McBurney's point. Abdominal distension and muscular rigidity of the lower right quadrant. Temperature $102^{3}/_{5}$; pulse 118; respiration 42. Operation two and one-half hours after admission. Anæsthetic, stovaine, 4 cg. in the first lumbar interspace. No narcotic. Abdominal incision three minutes after injection. One and one-half inch transverse right inguinal incision with McBurney separation of abdominal wall. Walled off abscess found extending down to the right of uterus. Abdominal incision immediately closed by buried and subcuticular catgut sutures. Wide incision through posterior vaginal cul-de-sac. Evacuation of abscess. Large gauze vaginal drain. Duration of combined operations twenty-four minutes. Pulse after operation 110. Respirations 30. Temperature 101. (Secondary symptoms absent. Packing removed on the fifth and sixth days. Out of bed on the seventh day; discharged on the fourteenth day.)

CASE 19. *An incision for the exploration of the skull.* The following patient, Tillas W., is a robust colored laborer, 27 years of age. He is about to be discharged from the hospital and is presented to show the advantage of an incision we employ in nearly all craniotomies. About two weeks ago (admitted October 24, 1911, discharged November 12, 1911) he was brought to the hospital by a supposed friend who said that the patient had been hit with a brick. He had involuntary discharges from the bladder and bowel, was unable to speak intelligently, could not write his name or any letter but understood what was said to him. At times he uttered parts of words. The pulse gradually fell from 78 to 56, but the respirations remained at 22. Narcotic anæsthesia reinforced by two ounces of ether was given. An incision was carried over the vertex from one mastoid to the other and the anterior and posterior segments of the scalp pulled back from the bone as is done at an autopsy. (Fig. 20.) In this way the entire calvarium was readily exposed. There was a large pond fracture of the temporo-occipital region upon the left side from which a linear fracture extended to the occipital protuberance. The depressed bone was freely removed, the linear fracture traced, an extradural hæmatoma evacuated, the dural vessels ligated and the wound closed without drainage. The aphasia has rapidly improved since the operation.

With the rather large skull circumference of 23 inches, a 14-inch incision connects one mastoid region with the other and permits the exposure of any or of every part of the vault of the skull. Had this fourteen-inch incision been curved to form the usual U-shaped flap the flap would have had an approximate length and breadth of five and one-half inches, and much less than one-quarter of the skull would have been exposed. In this particular case a second incision would then have been necessary

Fig. 20. Diagram showing coronal incision of the scalp. This simple incision enables an exposure of the entire skull with the minimum of hæmorrhage or traumatism. Incision (B) is employed where it is only desired to expose the subtentorial area.

to permit a complete exposure of the line of fracture, and even then the possibility of fracture upon the opposite half of the cranium would not have been excluded. The incision divides comparatively few blood vessels, nerves or other important structures and insures a maximum of exposure with a minimum division of the skin. It gives, as you see here, a scar that is inconspicuous and that is entirely covered by hair. Although we have temporarily resected large flaps of bone and have replaced them, we have never observed necrosis. We therefore consider an osteoplastic flap unnecessary. For subtentorial operations, if there be no reason for exposing the vault, a similar incision placed more posteriorly, as shown in the illustration, may be employed.

November 14, 1911

CASE 20. *Sclerotic ulcer of anterior wall of pylorus. Resection and suture.* William C. Age 45. Single. Gardener. American. Father died of disease of the stomach. Patient has had digestive disturbances since eight years of age. Typhoid fever fifteen or eighteen years ago. Severe between the ages of 18 and 25. Paroxysms of pain in the upper abdomen also occurred when the patient was about 35. Constant digestive trouble with paroxysms during the past three or four years associated with vomiting. The pain is most severe about 11 to 12 A. M., 3 to 6 P. M., and 11 P. M. It is relieved by vomiting and at times by taking a small amount of food. There is sour belching, and some burning pain which extends to the back, but is especially marked about the upper part of the right rectus. At times it is excruciating. Pressure

affords some relief. Total acidity 84; free hydrochloric acid 54 three and one-half hours after Ewald breakfast. Starch poorly digested; little mucus; total quantity excessive. Moderate gastrectasia. Dentition poor. Diagnosis. Sclerotic ulcer of the duodenum. Anæsthesia, two injections of morphine ⅙ gr.; scopolamine 1/100 gr.; one injection of apomorphine 1/15 gr., stovaine 4½ cg. through the first lumbar interspace. Operation started three minutes after intradural injection. Vertical incision through the right rectus immediately exposing callous ulcer the size of a ten cent piece involving the pyloric ring anteriorly. Ulcer demonstrated and excised (Fig. 13). Wound closed in a vertical direction, enlarging the pyloric opening, by two rows of continuous fine Pagenstecher sutures (Fig. 14). A few reinforcing individual sutures introduced, abdomen closed without drainage by four layers of buried chromic catgut and the skin approximated by a continuous buttonhole suture of fine Pagenstecher. Imbrication of anterior sheath of the rectus. Duration of operation and demonstration twenty-eight minutes. Pulse 68, respirations; 22 before operation, 56 and 20 after operation. (Secondary symptoms, catheter required the first two days. Sips of hot water followed by increasing quantities of liquid food after the first twenty-four hours. No vomiting. Primary union. Out of bed twenty-four days after operation. Discharged thirty days after operation. Patient's stay in the hospital prolonged from patient's disinclination and the lack of suitable home accommodations. Patient had lost about fifteen pounds previous to operation. Two months after operation there had been no return of the pain, and the patient had gained about ten pounds in weight.)

CASE 21. *Ventral hernia. Diastasis of recti. Obesity. Ovarian cyst. Ovariotomy. Herniotomy. Lipectomy. Reconstruction of abdominal wall. Secondary diabetes. Recovery.* Mrs. Mary F. Age 47. German. Housewife. Has had three children and several miscarriages. For six years has had progressively increasing pain on the right side of the abdomen, with a mass protruding at the navel. Anæsthetic, morphine ⅙ gr.; scopolamine, 1/100 gr.; two injections. Spinal anæsthesia, 4 cg. of stovaine in the first lumbar interspace. Operation started four minutes after intradural injection. Transverse elliptical excision of a mass of abdominal skin, hernial sac and submucous fat weighing 4½ pounds. Large ovarian cyst removed. Exploration of the abdomen. Approximation of the recti by broad imbrication by number one chromic catgut. Suture of enormous skin incision by interrupted silk worm gut and continuous button hole suture of fine Pagenstecher. Duration of operation thirty-eight minutes, incision about seventeen inches long. (Secondary symptoms, the patient voided an excessive quantity of urine, and developed free and repeated vomiting on the second day. Urine showed a high specific gravity, a trace of albumin, and sugar. Two days after operation patient was very restless and the following day became delirious, especially at night. Large quantities of sodium bicarbonate were given by rectum and mouth, as diabetic coma was feared. Gradually the patient improved, and was permitted to be out of bed fifteen days after operation. Stitches removed on the eighth day. Primary union. Patient discharged 26 days after operation. Reported well in March, 1912.)

CASE 22. *Recurrent carcinoma of stomach following partial gastrectomy in two stages. Exploratory incision. Metastases found preventing radical excision.* Mr. Joseph A. Age 47. German. Baker. Family history negative. Abdominal section May 3, 1911, for cancerous pyloric obstruction. At this time patient was very cachectic and emaciated. Gastric examination showing retention, free HCl, 10 to 15, total acidity 38 to 40, lactic acid and Oppler-Boas bacilli absent, few leucocytes. Condition was so advanced that only gastro-enterostomy, under spinal anæsthesia was done. On May 29, 1911, the patient having rapidly improved, a partial gastrectomy, also under spinal anæsthesia, was done. Progressive improvement and about forty pounds gain in weight until four weeks ago when intermittent vomiting of yellow, sour material, associated with a burning sensation in the epigastrium and throat, developed. Total acidity 38; Free HCl 10. No lactic acid. Present operation attempted to determine the feasibility of removing recurrent malignant growths from the stomach. Anæsthesia, morphine ⅙ gr., scopolamine 1/100 gr. followed in one hour by apomorphine 1/15 grain. Spinal anæsthesia, 5 cg. of stovaine in the twelfth dorsal interspace. Operation started four minutes after intradural injection. Abdominal exploration showing hard, irregular mass about the gastro-enterestomy opening, with carcinomatous plaques upon the transverse colon and upon ten inches of the bowel below the gastro-intestinal junction. Liver nodular from interstitial change, but without secondary growths. The necessary resection of transverse colon, of a segment of stomach, and the twelve inches of involved jejunum considered to be beyond the patient's limited power of endurance. Abdominal incision closed. Layer suture of the abdominal wall, continuous celluloid linen for the skin. Pulse 74, weak, respirations 18 before operation; 72 and 24 at the end of operation. Duration of operation twenty-one minutes. (Secondary symptoms, no vomiting until the seventh day when the patient was permitted out of bed. The patient was discharged on the eleventh day, symptomatically improved.)

At the present time, for advanced inoperable carcinoma, we are trying the subcutaneous or neoplastic injections of embryonic emulsion. Fichera, of Rome, Italy, has directed attention to the anti-neoplastic action of fœtal products and has obtained apparent cures from the injection of fœtal autolysates. Thus far we have not used the fœtal autolysates suggested by Fichera, but have injected freshly prepared fœtal emulsion made with glycerine, using from 1 to 4 cc. every two or three days with results that in some instances have been distinctly encouraging.

CASE 23. *Multiple necrotic interstitial uterine fibroma. Vaginal hysterectomy by the clamp method.* Mrs. Elmira S. Age 55. American. Housewife. Four children; two miscarriages. Menopause six years ago. Persistent uterine hæmorrhages, for which she has twice been curetted without relief. Multiple necrotic and semi-gangrenous uterine fibroids. Anæsthesia, two preliminary injections of morphine ⅙ gr.; scopolamine 1/100 gr. Spinal anæsthesia, by 4 cg. of stovaine in the first lumbar interspace. Operation started five minutes after intradural injection. Vaginal hysterectomy with Pryor's clamps. Pulse 90 and respiration 24 before operation; 76 and 18 after operation. Duration of operation nineteen minutes. (Clamps removed at the end of forty-eight hours. Packing removed on the fifth day. Patient permitted out of bed twelve days after operation. Discharged thirteen days after operation.)

CASE 24. *Streptococci infection in an amputation stump. Incision and drainage.* Mr. Joseph S. Age 18. Leg had been crushed and amputated under crude conditions in the

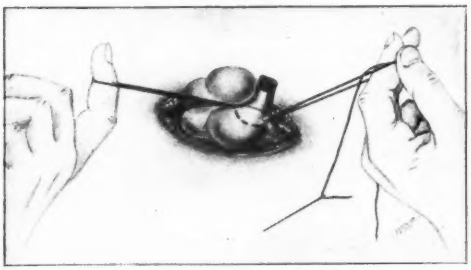

Fig. 21. *Appendectomy.* Simple method of fixing the appendiceal stump so as to prevent its premature retraction within the wound. The base of the appendix has been crushed and divided between the forceps by a heated metal knife. A purse string suture has been introduced about the base of the appendix, a small loop catching the base of the meso-appendix to compress any contained vessel. A loop of the celluloid linen is held by an assistant, the ends by the operator, until the stump has been satisfactorily inverted.

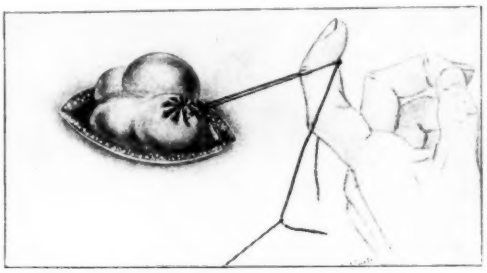

Fig. 22. *Appendectomy.* Second step. The appendiceal stump having been inverted, the assistant releases his loop, and by traction the operator obliterates the small opening. The stump of the meso-appendix seen below is then lifted up by forceps and the thread is tied the second time about this stump, in this way again occluding the opening in the cæcum, and also ligating the meso-appendix a second time.

far west, about eight months ago. A persistent sinus remained for which a Gritti Stokes amputation was done about six weeks ago. The patient, who has been dressing the stump at home, has now developed a severe infection involving the stump and the tributary lymphatics and inguinal lymph nodes. Anæsthetic 4 cg. of stovaine in the second lumbar interspace. Operation started one minute after the injection. Anterior flap raised from the patella freely opening an abscess cavity. No necrosis of the bone found. Flap separated from adjacent tissue by iodoform gauze and large boric acid dressing applied. Duration of operation two minutes. (Secondary symptoms, no vomiting. Catheter required once. Stump continued somewhat painful. Inflammatory symptoms rapidly subsided. Two weeks after the drainage operation, at the request of the patient, the patella was removed under spinal anæsthesia. No necrosis was found but the tissues were œdematous. Patient discharged nine days later.)

CASE 25. *Obesity and relaxed abdominal walls. Gall stones. Relaxed outlet. Lipectomy. Abdominal exploration. Cholelithotomy. Perineorrhaphy.* Mrs. M. D. Age 36. Weight about 250 pounds. American. Seven children. Mother died of "galloping consumption." The patient has had a progressive abdominal enlargement for the past year, diagnosed by one physician as pregnancy, and by a second as an intra-abdominal tumor. She has had attacks of gall bladder colic with the passage of gallstones. Anæsthesia, three injections, morphine, 1/6 gr., two injections of scopolamine 1/100 gr.; followed by one injection of 1/15 gr. of apomorphine. Stovaine 4½ cg. injected into the first lumbar interspace. Vaginal operation started four minutes after intradural injection. Submucous perineorrphahy, duration eight minutes. Abdominal operation, removal of a transverse ellipse of abdominal skin and underlying fat weighing over thirteen pounds. Secondary elliptical incisions at the end of the primary incision to remove the redundancy of fat above the hips. (Figs. 15, 16, 17, 18 and 19.) Abdomen explored, upper abdominal skin flap raised, short incision through the underlying layers of the abdominal wall over the gall-bladder, gall-bladder opened and a number of stones removed and a large drainage tube sutured in gall-bladder by two inverting purse string sutures. Stab wound made through the overlying skin flap and tube brought through the external abdominal wall. Correction of rectal diastasis with lateral overlapping or imbrication of the layers of the abdominal wall. Closure of the transverse skin incision nearly twenty inches in length without drainage by interrupted figure of eight sutures of silk worm gut and continuous coapting button-hole cuticular sutures of fine Pagenstecher. Duration of abdominal operations, fifty-five minutes; duration of the anæsthesia, one hour and fifteen minutes. (Secondary symptoms, no vomiting. While dreaming the patient rolled out of bed on the second night. Primary union. Back rest on the tenth day. Returned to Allentown, Pennsylvania, on the nineteenth day, much pleased that she can now sit in an ordinary arm chair.)

CASE 26. *Recurrent appendicitis. Hæmatoma of ovary. Appendectomy. Resection of ovary.* Miss Mary B. Age 16. Stenographer. Recurrent appendiceal attacks for the past year, associated with nausea and constipation. Operation about five hours after admission. Anæsthesia, morphine 1/6 gr.; stovaine, 4½ cg. in the first lumbar interspace. One and one-half inch incision starting one-half inch internal to right anterior iliac spine. McBurney separation of layers of abdominal wall. Small retractor introduced exposing appendix, which is grasped by forceps and drawn through the wound. Meso-appendix ligated and a purse string suture placed in the cæcum one-half inch from the base of the appendix with a loop encircling the base of the divided meso-appendix. (Fig. 21.) The base of the appendix is crushed in two places divided by a hot metal knife and the stump cauterized upon the crushing forceps by the handle of the knife. The stump is now inverted, the purse string suture tied (Fig. 22), and then tied a second time over the stump of the meso-appendix, serving to ligate the vessels twice and to give a second means of occlusion of the cæcum. Cæcum dropped, pelvis explored by the finger and a large hæmatoma of the right ovary found. Ovary and tube brought into the wound by the finger, fixed by hæmostatic forceps applied near the poles and a wedge shaped excision of cystic portion performed. Duration of operation fifteen minutes. (Secondary symptoms: Patient vomited twice; out of bed on the third day. Discharged 8 days after operation. Cured.)

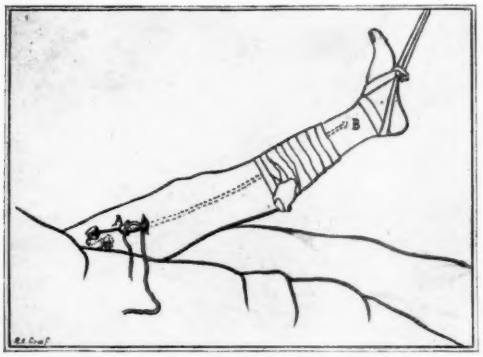

Fig. 23. Author's method of extirpating the internal saphenous vein. The varicose ulcer is protected by a bandage and the vein exposed through a short transverse incision below the saphenous opening. The vein is ligated (C) and divided after passing a flexible acorn tipped shaft as far down the vein as possible. The upper end of the entered vein is firmly tied to the shaft of the instrument as indicated at (A). The lower tip of the instrument located at (B) is exposed by one-half inch incisions, grasped and by traction the instrument and the long segment of attached vein removed, rupturing the venous radicals with little secondary hæmorrhage.

To cauterize and divide the appendix we use an old cartilage knife usually heated by an alcohol lamp. We have never had an intracæcal hæmorrhage after inversion of the appendix stump.

CASE 27. *Varicose veins of the leg. Venectomy.* Mr. Joseph C. Age 37. Austrian. Bartender. Uses alcohol and tobacco freely. No recollection of previous illness Varicose veins of the right leg present since youth; with tendency to ulceration for three years. Anæsthesia, two injections of morphine $^1/_6$ gr. and scopolamine $^1/_{100}$ gr. Stovaine 4½ cg. through the second lumbar interspace. Operation started four minutes later. One inch incision below the saphenous opening; ligation of internal saphenous vein, introduction into the lumen of the vein of special extractor which is carried in the vein to the middle third of the leg and there exposed by one-half inch incision. The upper end of the vein having been divided and tied to the instrument (Fig. 23), a segment of about twenty inches of vein is removed by traction upon the instrument through the lower opening. Catgut for ligatures and skin sutures. Duration of operation five minutes. (Secondary symptoms, no vomiting, slight headache the second day. Primary union. Out of bed on the eighth day. Discharged on the tenth day.)

CASE 28. *Operations for eleven miscellaneous conditions in one patient.* Mrs. A. Y. Age 50. Housewife. Cystocele, rectocele, intra-abdominal adhesions, appendiceal adhesions, small uterine fibroid, retroverted uterus, obesity, with redundant abdominal wall, bunions, bilateral hallux valgus. Operation. Scopolamine, morphine; ether (by request). Duration of anæsthesia two hours and ten minutes; amount of ether 20½ oz. Operation started twenty minutes after beginning ether. Duration of operations one hour and fifty minutes. Operations, colporrhaphy, perineorrhaphy, partial vaginal fixation of uterus, appendectomy, abdominal myomectomy, removal of three pounds of abdominal fat, exploration of gall-bladder and stomach, uterine ends of round ligament sutured under internal rings, imbrication of abdominal walls, resection of metatarsal bones of great toes, excision of bunion on right side. (Secondary symptoms, marked post-operative ether sickness, nausea, tympany etc. Primary union of wounds. Recovery.)

RHINOPHYMA[1]

BY JAMES C. WOOD, M. D., CLEVELAND

PATIENT, aged 65, had been a daily drinker of spirits for many years. While yet a boy there was an unnatural redness and irritability of the skin of the nose. The present enlargement, however, began some twenty years ago and gradually became worse until at the time of the operation there was an irregular tumor, almost as large as a small orange, possessing several lobes, which is well shown in Fig. 1. Some four or five years ago nitric acid was injected into the growth. The family history is good. Eighteen months ago there were symptoms of a slight paralytic stroke. Heart's action somewhat irregular. The tumor has grown rapidly during the last four years.

On August 22, 1911, under whiskey and cocaine anæsthesia, the entire growth was removed with a sharp scalpel. The hæmorrhage was very profuse and many bleeding points had to be secured in catgut carried around the bleeding vessels by means of a fine needle. General oozing controlled by the application of adrenalin. A portion of the left ala had to be cut away in order to remove the entire growth. This incision was closed with fine catgut. The dressings were held firmly in place with adhesive strap and a roller bandage. One day later the dressings were removed and the entire raw area covered with Thiersch grafts, removed from the left arm. Usual dressings which were left undisturbed for 48 hours. The dressings were then removed and the grafts were found to be healthy in every way. In one week's time it was difficult to determine the line of union between the normal skin and the grafts. The final results, which are almost perfect, are shown in Fig. 2.

The patient is a prominent lawyer and was handicapped for twenty years of his life by the very great deformity of his nose, which is not perfectly shown in Figure 1, for the reason that the photograph was taken some two years previous to the time of the operation. He declined political preferment because of the conspicuousness of the nose, which naturally was a source of very great embarrassment to him.

[1] Read before the Surgical and Gynecological Association of the American Institute of Homeopathy, June, 1912.

Rhinophyma is but an extreme form of acne rosacea and is in reality an elephantiasis involving all the structures of the skin. In the case reported, I believe that the conditions were aggravated by the injection of the nitric acid, which left in the middle of the larger growth a cavity containing at least a teaspoonful of thick, sebaceous matter. Not very many cases are reported in medical literature, although I think nearly all surgeons have seen one or more of the extreme cases.

One is reported by Dr. Russell S. Fowler[1] of Brooklyn, New York. Dr. Fowler operated by removing the nodules one by one, dissecting from the nodules the superficial layers of skin and using these layers to cover the raw area after the growth was removed. Hæmorrhage in his case was very slight.

F. B. Jefferiss,[2] F. R. C. S., reports a case of a man 64 years of age who had had the trouble 40 years. His habits were temperate and there was no significant family history. He operated under chloroform anæsthesia, removing the entire superfluous tissue in one piece by making two lateral incisions, leaving a V-shaped shallow cavity behind with the incision extending down to the cartilage. The flaps were then trimmed and the wound closed with catgut. The deformity in this case was not great and was the typical "hammer nose" quoted by the older writers. The results were good.

MM. Wickham et Degrais[3] report a case which was much benefited by the use of radium. The first result of the application of radium was a very marked congestion and irritation of the sebaceous glands, which subsequently became atrophied. The results were not nearly as satisfactory as those obtained by radical surgical work.

Keen[4] records a case which was previously reported in the Annals of Surgery for 1904, in which he obtained very good results by cutting away the growth and permitting the parts to heal by granulation. The results were, however, judging from the illustrations, not nearly so satisfactory as in my case where the skin grafts were used.

Drs. Grover W. Wende and Charles A. Bentz[5] of Buffalo, record a case occurring in a German of sixty-nine, who had for years been a curiosity in the city of Buffalo. He was a hard drinker, beginning with hard cider. The disease first began with a reddening of the tip of the nose, which gradually increased. The cheeks became unnaturally red after drinking. The congestion seemed to be influenced by the changes of temperature, over-feeding, or the use of hot tea or coffee. As time went on the condition became permanent and was speedily followed by the appearance of pustules and papules disseminated over the face. Before his death, which resulted from probable cancer of the liver, the largest diameter of the growth from the base measured four and three-fourths inches; transversely, three and one-fourth inches; at right angles with the face, three inches. There were besides, eight smaller tumors situated about the tip of the nose, the largest of which was nearly round and was one and one-half inches in diameter. The smaller ones were sessile, while the larger two had pedicles and would oscillate at every movement of the head.

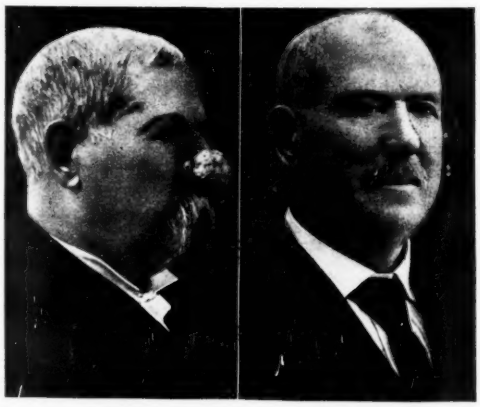

Fig. 1. Fig. 2.

Drs. Wende and Bentz made a careful microscopic examination of these growths after death, the patient obstinately refusing surgical relief during life. The most striking microscopic change was the enlargement of the sebaceous glands. "This enlargement was cystic, due to hypertrophy and dilatation of the excretory ducts, probably caused by retained secretions, as well as the active hyperplasia of the glands. The lobules were very large, at times subdividing and surrounding the ducts. The sebaceous glands occupied the superficial portions of the skin, and its warty and irregular aspect was due in part to this fact. The sebaceous glands also occupied the deeper portions and showed marked hypertrophy and complexity; very few revealed connection with the hair follicles. The length and dilatation of the excretory sebaceous ducts were striking." The connective tissue was also greatly hypertrophied and the blood vessels dilated and augmented, the walls being thickened because of the hypertrophy. The veins were also dilated though the walls were thin.

In none of the cases recorded were the Thiersch grafts used. I could not apply them immediately in my case because of the profuse hæmorrhage which was present. I can but feel that the simpler way to operate is to follow the method adopted by myself, namely, remove quickly and rapidly the entire growth down to the cartilage and resort either immediately or later to the Thiersch grafts.

[1] American Journal of Surgery, August, 1911.

[2] Lancet, October 28, 1911.

[3] De la Société Française de Dermatalogie et de Syphiliagraphie, 1912.

[4] Keen's Surgery, Volume iii.

[5] Journal of Cutaneous Diseases Including Syphilis, October, 1904.

EDITORIALS

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NOVEMBER, 1912

AN INTERNATIONAL ABSTRACT OF SURGERY

The development of American and English surgical journalism, urged on by an increasingly critical profession, has reached the point where there is demanded of it a comprehensive, authoritative index and abstract of the surgical literature of the world put forth under one cover. Mechanically such a task seems easy of accomplishment, as it means the assignment of tasks, the employment of translators and the multiplication of proofreaders and printers, but as it means in addition the judicious selection of material, the estimation of the reliability and reputation of contributors of articles and monographs, the intelligent reproduction in abstracts and reviews of the author's real meaning, the task assumes grave proportions with serious difficulties to solve.

Heretofore in the English speaking countries the abstract departments in our best journals, while often well done, have lacked comprehensiveness and completeness. The work is too often wrought by overworked young men of the profession without sufficient remuneration, or by the literary hack who is out of touch with the practical side of the subject he is expected to interpret. However, abstracts from either of these sources may be well done if the selections are judiciously made. Here, however, is the difficulty: No matter how well versed the directing editor of a comprehensive abstract journal may be in the literature of a subject or subjects involved in any department of medicine or surgery, he is at a distinct disadvantage when he attempts to estimate the value of the literature and the producers of the literature of foreign countries.

These considerations and others even more obvious have eventuated, after a year's consideration, correspondence and interviews with foreign contemporary editors and publishers of surgical journals in France and Germany, in the organization of a plan for the establishment of a supplementary magazine to SURGERY, GYNECOLOGY AND OBSTETRICS to begin early in 1913, which will index all contemporary surgical literature, and abstract in all departments of surgery all literature worthy of abstracting, from all countries.

The plan which finally has been evolved includes: First, a reciprocal contract between SURGERY, GYNECOLOGY AND OBSTETRICS and the leading abstract journal of France which now abstracts, reviews and indexes in French the surgical literature of all countries; second, a similar arrangement with two German abstract journals recently authorized by the Surgical and Gynecological Congresses of Germany, covering respectively abstracts of surgery and abstracts of gynecology and obstetrics; and third, the organization of a representative editorial staff on the part of SURGERY, GYNECOLOGY AND OBSTETRICS sup-

plementing the present editorial staff, to prepare indexes, abstracts and reviews of all surgical literature, to be printed in English.

This plan, while it will not interfere with the financial or literary independence of any one of the journals under this contract, will enable SURGERY, GYNECOLOGY AND OBSTETRICS to receive and to publish in English abstracts prepared in the respective countries by men acquainted with the reliability and standing of the contributors; since we are to receive from the French source, as published in the French abstract journal, the index and abstracts of all contributions in all branches of surgery emanating from Holland and Belgium, France, Spain, Italy, and other Latin countries, and likewise to receive from the German source, as published in the German abstract journals, the index and abstracts of all contributions in all branches of surgery emanating from Germany, Austria, Norway, Sweden and Russia. This leaves the surgical literature of the United States and the British Empire to be indexed and abstracted by the editors of the Abstract Department of SURGERY, GYNECOLOGY AND OBSTETRICS, and the mechanical task of translating and arranging the material from our French and German contemporaries.

The comprehensiveness of such a plan, involving the combined efforts of three of the strongest publications in the scientific world, each speaking its own language to a constituency of a third of the civilized world, must compel a feeling of satisfaction to the most exacting critic.

This plan will not only insure comprehensiveness, but with three strong editorial staffs representing the different languages and able to speak authoritatively concerning the contributors and their contributions, will present a journal which for accuracy and authoritativeness will be superior to any that might be brought forth by one editorial staff attempting to cover all countries and languages.

The scope of the new journal will be extremely broad. Surgery in its most literal interpretation, together with borderline subjects dealing with pathology, medicine, physiology, anatomy, chemistry, electricity, Röntgenology, will be included. There will be a comprehensive department devoted to general surgery, which will be divided into subdepartments, and in addition the departments of special surgery will include gynecology, obstetrics, orthopedics, genito-urinary surgery, surgical Röntgenology and electricity, surgery of the eye, surgery of the ear and surgery of the nose and throat. Each department will have its consulting and abstract editorial staff under the supervision of a directing editor of the journal, at the respective editorial offices.

The journal in its completeness will consist of the following and will be printed in English:

1. A comprehensive index of surgery from all sources, arranged alphabetically under departments giving the author's name, subject of communication, and the journal from which the article is abstracted.

2. An abstract of the surgical literature from all countries, prepared by the combined efforts of our French and German contemporaries and our own staff for Great Britain and America. This will appear under departments and will include abstracts and reviews of (*a*) original articles, (*b*) monographs, (*c*) books, and (*d*) clinics.

This publication will be issued as a supplement to SURGERY, GYNECOLOGY AND OBSTETRICS and will more than double the present volume of this journal; it will be complete in itself and will be known as the INTERNATIONAL ABSTRACT OF SURGERY.

FRANKLIN H. MARTIN.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD MARCH 1, 1912, WITH THE PRESIDENT, DR. FREDERIC A. BESLEY, IN THE CHAIR

DR. WILLIAM FULLER presented "A Report on Exophthalmic Goiter Based on the Experience of the Members of the Chicago Surgical Society." (See p. 585.)

DISCUSSION

DR. A. J. OCHSNER: I think it was a happy idea to have these collective papers to which all of the members of the society have contributed, because from this report we have just heard we obtain conclusions which will have a great deal more weight than they would have if a report emanated simply from one member of the society. If we carry this idea through the various subjects that are prominent in the field of discussion at any given time, I am sure we will have very satisfactory results.

The conclusions Dr. Fuller has given I can subscribe to throughout. There are a few things that I will mention in the discussion, although I would be willing to accept the whole report as agreeing entirely with what I think of exophthalmic goiter.

He speaks of the microscopic structure of the thyroid gland in exophthalmic goiter. Ever since Professor Wilson, of Rochester, Minnesota, brought out his first paper on the histology of exophthalmic goiter, I have studied these goiters with a view to confirming or discrediting his theory. Every Sunday morning I examine all the microscopic specimens we have obtained during the week, and in all of our goiters I first examine the specimen and then determine what patient it comes from, and I have found that Dr. Wilson is right. Occasionally we have a mixed goiter in which the hyperthyroidism comes from certain nodules, while the goiter in general is a simple cystic goiter, or possibly a simple hypertrophy. I had one of these cases last Sunday morning in which the first section showed a simple cystic goiter in which the colloid material was exaggerated, but in which the walls were of themselves lined with the typical cylindrical epithelium, and in which it was impossible to tell the fact that the case was one of exophthalmic goiter. A second section from the same patient showed a typical exophthalmic goiter, so that if I had seen only the first specimen I should, of course, have made a diagnosis of simple goiter. I have had this occur a number of times in cases in which I made a diagnosis of simple goiter, but in which later on I had sections of other portions of the specimen and found the typical proliferative form which Dr. Wilson has described as being the typical microscopic picture of exophthalmic goiter. I believe, therefore, that Dr. Wilson's theory should be accepted.

Too much cannot be said about the margin of safety that Dr. Fuller has mentioned. I believe that in every case in which I have lost a patient, I can attribute the death to a lack of judgment in this regard. Looking at the conditions later I could say to myself, with better judgment I would have recognized the fact that in this particular patient the margin of safety was so slight, that she should have been carried on to the point at which the margin of safety would have been greater. Most of these patients will acquire that point, and should not be operated at all, or should have simply one of the vessels ligated. In waiting for this margin of safety to become greater, I have lost three patients without operation. I think one of the three died of fright. The other two patients died because they could not recover; they died within three or four days after entering the hospital. If I had operated on them, I might have given them a chance, but I did not do it. I believe they would have died had I given them this chance.

In several cases we have ligated both the superior vessels without any shock to the patient, and without any increase in the hyperthyroidism; in these we have been able, after a few weeks, to remove at least one lobe with safety. I have found also in these bad cases that there is very frequently a middle thyroid artery and, of course, many communicating veins. The anterior jugular vein in these cases is often larger than the external jugular vein ought to be.

Normally, the anterior jugular vein is so small that one can scarcely find it. I believe more judgment is required in the selection of cases suitable for operation than in anything else.

I have spoken before this society in the past concerning the manner in which we anæsthetize these patients. We give one quarter of a grain of morphine and one-hundredth of a grain of atropin half an hour before beginning the anæsthetic. The atropin prevents mucus from forming and getting into the larynx, the morphine removes the sensitiveness. We anæsthetize the patient fully with ether and then place the patient with the head up at forty-five degrees, and invariably finish the operation without giving any more anæsthetic. Since we have done that we have had no case of pneumonia.

The theory brought forth by Landstrom, in which he shows that it is the effect of the hyperthyroidism upon the cylindrical muscle of the orbit which holds the eye-ball back in the normal patient, has not been spoken of or written about sufficiently. That muscle is exactly in the same condition that the muscle of the heart is, or whatever muscle happens to be most affected. It is the relaxation of this muscle that causes the exophthalmos. Landstrom has shown also that whether the heart muscle or any other muscle has been thoroughly poisoned by the hyperthyroidism, after operation, that same muscle does not get any weaker, but it may not get stronger. You may have a slight reduction in dilatation of the heart but you will not have a complete reduction of this dilatation in these cases in which there has been severe poisoning, and so it is with the exophthalmos. Often there is a selective effect of the hyperthyroidism.

Dr. Fuller (closing the discussion): I have nothing to add to the discussion. I want to say a word about the report, which was based on the replies I received from different members of the society. I do not know in whose mind this idea originated, but I believe it will be the means of bringing out subjects in much better way than I can think of. If I had the work to do over again, I would ask for more time in which to frame the questions with the idea of condensing them as much as possible and bringing out the essential points we would like to have brought out, and furnish the replies in that order.

There are a few members of the society who did not reply to the questions I sent out, and there are members who should have replied because of the experience they have had with cases of exophthalmic goiter. Perhaps we did not give them sufficient time to hear from them. These questions were gotten up hurriedly, and the replies were hurriedly asked for. It is not an easy matter, with other duties to perform, to do these things, but next time we ought to have a more extended period, and I hope the next report will be a great improvement upon the one to which you have just listened. I wish to thank the members of the society personally for the replies they sent me.

CHICAGO SURGICAL SOCIETY

Regular Meeting Held April 5, 1912, with the President, Dr. Frederic A. Besley, in the Chair

Dr. Phemister reported a case in which Dr. Halstead ligated the internal carotid artery.

DISCUSSION

Dr. Arthur Dean Bevan: One interesting point in connection with this work to which my attention was called quite recently is this: I have had four of these cases of ligation of the carotid, fortunately without any deaths; but I have had this interesting experience which I wish to briefly relate. One of my cases was one in which there was a traumatic history. I ligated the common carotid. Apparently it was a success. The roaring in the ear disappeared; the exophthalmos receded, and the patient felt for a few weeks as though he was cured. Then the same noise again appeared in his ear; you could hear it with the stethoscope, and the exophthalmos became more evident, but not marked. I then ligated the internal carotid, and in so doing I pretty nearly killed him. He had aphasia and had hemiplegia, and at the time of the operation I noticed this very interesting fact: where I had ligated the common carotid and followed it by the ligation of the internal carotid on that side, the internal was quite as

large as a normal internal carotid, and that had been maintained by the free anastomosis from the branches of the external carotid on the other side with those of the involved side. Right at this junction of the internal and external carotid there was a well marked leak and the internal carotid maintained by this free anastomosis.

It seems to me, there is an exceedingly valuable lesson in that particular case. Although the man did not die, he had very marked effects from the second operation of the ligation of the internal carotid, although the common carotid had been ligated at a previous operation.

Is not this conclusion warranted?—that in these cases, with the very great danger of softening there, with a cutting off of the arterial supply, that the normal procedure should be this: ligation first of the common carotid. If that is not successful, then the exposure of the common carotid at its point of division into the internal and external, and possibly even a second step in the operation of cutting off the main portion of the collateral circulation, leaving possibly the superior thyroid, or possibly the superior thyroid and the lingual. These ligations are not at all difficult. They can be readily done under local anæsthesia, and if that is not successful, then finally ligation of the internal carotid itself. I think that conclusion is warranted from this and similar experiences that are found in the literature.

DR. A. E. HALSTEAD: This was the second case I have operated on. In one case I exhibited here two years ago, I followed the procedure Dr. Bevan has mentioned; namely: ligating the common carotid. The ligation of the external carotid proximal to the superior thyroid, leaving the superior thyroid for collateral circulation. I believe that procedure would be the best one. The mortality in any operation where we have to ligate the common carotid is 10 per cent. In the last case in which there was double exophthalmos, with the loss of one eye, I ligated the external and internal carotid. I ligated the common carotid first, and the internal carotid filled up so completely that I was forced to ligate that and to ligate them all. The reason why I would not ligate the common carotid alone is because fifty per cent of the cases recur. On the whole, ligation of the internal carotid is a safer operation than ligation of the external carotid, taking all cases together. The operation of choice is the ligation of the common carotid, with ligation of the external carotid above the superior thyroid where the patient is of middle or advanced age. This last case was the only one that died.

This specimen exhibited by Dr. Phemister is of interest because there are only fifteen cases on record in which autopsy showed an opening between the sinus and carotid. A great many autopsies have been made without such an opening having been found. It is also of interest because of the slight degree of trauma. This man was in a scuffle, he was a soldier and received a blow in the face, and soon after developed the pulsating exophthalmos.

DR. L. L. MCARTHUR: I desire to record a case, not yet reported, of a teacher at the University of Chicago, who, in a stage ride in Yellowstone Park, was thrown from the top of the stage and sustained a fracture of the base of the skull. Others were injured at the time. This patient was so seriously injured and apparently so nearly dead that others were helped before they did anything for her. They desired to leave the body and to come back for it, because to all appearances she was dead. A sister, who was also on the trip, insisted on the body being taken to the next station. When they reached there the patient revived, and after two or three months in a hospital in the West she was brought to Chicago with a pulsating exophthalmos. Vision was not destroyed in the eye, the optic nerve maintaining its integrity. Ligation of the internal carotid was made without untoward results, so far as the nervous system was concerned, with complete relief of the exophthalmos, and the roaring noise or sounds which had so disturbed patient. Patient made good recovery.

DR. ARPAD G. GERSTER, of New York City, read a paper (by invitation) entitled "Unsuccessful Surgery in Disorders of the Gall Ducts, Together with a Consideration of Naunyn's Cholangiolitis." (See p. 572.)

DISCUSSION

DR. FRANK BILLINGS: I consider it a compliment to discuss any subject before this society, and I consider it a greater compliment to be asked to discuss this subject by a master. I am more than pleased to have heard the paper, because it has shown that Dr. Gerster is an internist who practices surgery.

I have been always greatly interested in infections of the gall tracts, of course, but more particularly in the last fifteen years because of the broader subject that has come to the medical man through surgical operations and a better knowledge of the disease. Before surgery came to the relief of patients suffering from infections of the gall tracts, there was a method of treatment which recognized some of the principles enunciat-

ed in the paper read by Dr. Gerster to-night. The French recognized cholangeitis as an infective process even before bacteriology was well known, and they called the condition of infection of the gall tracts hepatic intermittent fever. It is fully thirty years ago since Dr. William Pepper read a paper on that subject before the New York Academy of Medicine, or perhaps it was one of the Cartwright Lectures — I have forgotten which — in which all of the knowledge then known was brought out; and in the years which followed, we physicians called these conditions, in which we could not demonstrate malaria, and in which sometimes there were evidences of infection of the gall tracts, hepatic intermittent fever. The recognition of stasis in the gall tracts was also noted, and internal drainage by means of the waters, particularly the waters of Carlsbad, was resorted to. Possibly some of the surgeons who suffered from gall-stone disease, or from infection of their own gall tracts, have even recently used the Carlsbad waters instead of permitting themselves to be operated. I think it is said that Professor Koenig operated upon his father for gall-stone disease, while he himself suffering from the disease went to Carlsbad.

All stasis of the gall tracts, manifesting itself in jaundice is, of course, not an infection; and the infection which occurs in the gall tracts comprises many different degrees. In disease of the pancreas, for instance, due to carcinoma, or to possibly chronic pancreatitis, in which the infection is not sufficient to produce systemic disease, stasis will occur in the gall tracts with a marked degree of jaundice without any systemic symptoms existing except those due to cholemia; that is, there will not necessarily be any fever or chills, but on top of that stasis infection may occur, and all the phenomena which have been so well mentioned by Dr. Gerster. There is no question but that the disease which we call catarrhal jaundice or epidemic jaundice is an example of cholangeitis. Recently in Chicago there was an epidemic of that disease. I have eight patients suffering from so-called catarrhal jaundice in the hospital at one time. Usually it occurs with greater rarity, but it is unquestionably infectious and there is infection of the smaller ducts; but when it subsides, which is usually within a week or ten days, the stasis disappears with it.

Infection of the gall-bladder is particularly interesting to me because of the relation it has to systemic disorders, and, of course, that relates also to the infection of the gall tracts.

In patients whom I examine and make a diagnosis of cholecystitis or of cholangeitis, usually the primary question is asked by them, "Have I gall-stones?" Perhaps they have colicky attacks. I invariably answer nowadays, "I do not know, and it does not make any difference whether you have or not. You have infection of the gall-bladder or of the gall tracts, and that is the important thing. The gall-stone is of secondary consideration. If you have a gall-stone, it doubtless promotes more or less of the infection, but the infection is the important thing."

I was very glad to hear what Dr. Gerster had to say about therapy. Before I speak of that, let me indulge myself with my own conception of the treatment of cholecystitis and cholangeitis.

I look upon both as practically always a surgical disease. Of course, cholangeitis in the form of what we call catarrhal jaundice I do not so consider. I have often wished that I could have the consent of a patient suffering from Hanot's disease to have his gall tracts opened and drained to see what the final result will be. I have asked half a dozen men to submit to that, but they have not done so, but where the infection in the tracts themselves is incident to some enteric trouble, perhaps it is hæmatogenous, and I look upon these as surgical conditions. It may remain in the hands of the physician to give the patient preliminary treatment, and I believe this is often a necessary thing. We know that certain substances are excreted with the bile. We know empirically that a thorough bowel movement every day by means of Carlsbad salts or any other saline — although I do not believe there is anything specially specific in the Sprudel Carlsbad salts — will relieve a patient of stasis, provided the common duct is not entirely obstructed; and by such a measure of helpfulness in the removal of stasis, we diminish the infection to some degree in some instances—I would not say in all—and the relief of some of the infected biliary secretions, preliminary to operation, makes the operation a little less dangerous than it otherwise would be. I have in many instances kept patients suffering from these infections under my care, feeling they would be benefited by it; and not only that, but subsequent to operation, depending upon the severity of the infection, for where there is a continuance of the jaundice, the fever, and so on, such patients perhaps need surgical drainage continued; but they need more care in diet, in perhaps the use of certain drugs which will be excreted with the bile, than the general surgeon gives.

A surgeon, rather prominent in the Western

country, came to me not long ago, he having been operated for gall-bladder disease, his gall-bladder was drained, and apparently he recovered. Following this he went to work. He had a recurrence of some of the gastric symptoms, such as pain after eating, gas, bloating, and finally a little jaundice. I told him he was working too soon—he was easily fatigued—that in working it helped to bring back stasis in his gall passages. I advised him to keep quiet and to take a form of salicylic acid, any form, I did not care what. We know salicylic acid is secreted with the bile, and while it is only mildly antiseptic it is helpful; to keep his bowels open every day with any saline he might select, or with olive oil or anything else. He followed that course, and within a month considered himself well, and again went to work, and again within a month he had a return of the same symptoms. I did not feel that he had a stone. This time he remained at rest a long period at sea, and since that time has not had a recurrence.

I attended a patient for gall-bladder infection with gall-stones years ago. I advised operation at the time, but he refused it. He went to Carlsbad, made a good improvement, came back, worked for a year, was elected to a judgeship and on the bench, and had great anxiety because of his desire to make a good record. He had repeated biliary colic, and finally submitted to operation by Dr. Murphy. Gall-stones were removed, and the gall-bladder was drained. Within a year there was a recurrence of the trouble, and after ineffectual attempts to relieve his infection, a secondary operation was done for the removal of the gall-bladder and adhesions without the removal of a stone. I believe no stone was found. Two years subsequently there was a recurrence with jaundice, chills, and fever. This was in November last. After a month in bed, during which he was very ill—he lost in weight a great deal, had nausea and vomiting, and a good deal of tenderness over the upper abdomen—he went south to New Orleans, where he remained in bed a good deal of the time, but in the sunshine, made a rapid recovery, gained thirteen pounds in weight, came back, and went on the bench, and again had a relapse of his fever, chills and jaundice. Again, he took a rest, but this time only for a day or two, then resumed his duties on the bench, and then a second attack. This time it was not a colic, but great soreness in the upper left epigastrium, in the region of the pancreas. He was again advised to rest. He had had two operations, and nearly died in the second. In conference with Dr. Murphy, who performed both operations, I advised him to quit, to go on a long vacation, but he did not at the time. He again had another attack with jaundice, fever, and chills, with a temperature of 104, rapid pulse, exhaustion, etc. Recently I received a telegram from him, saying he had recovered from the attack and was on his way to California. This is like one of the patients described by Dr. Gerster.

On the other hand, it seems to me, from some patients I have seen, that possibly the infections may not be entirely removed by the surgical drainage, even the continued drainage; and with a patient who is in a state of exhaustion, with less resistance, the infection returns without gall-stones, and possibly with the infection the pancreas becomes infected with possibly pancreatic stone formation. But the man to whom I have referred has gone away, to remain two months; after this long rest should a recurrence take place he ought to submit to another operation. Finally, there is a reason in my estimation for these patients to be operated upon far beyond the local relief which you give by operation. You surgeons do not have the opportunity to study your patients beyond the time that you see them preparatory to making your diagnosis and operation, and the short time which you see them immediately after operation, for they leave you. Perhaps some of you ask them to come back, but you do not study them. You usually do not know anything about their future.

Infection of the gall-bladder occurs as a rule in the afternoon of life. The individual has the degenerative changes of his age. He has a lessened resistance. If he has infection that is walled off in his gall-bladder, or if it is some infection associated with the gall-bladder and gall tracts, perhaps not enough to make him an entire invalid, he has occasionally attacks of colic with or without gall-stones. He goes to Carlsbad, or takes salines, and he is relieved for the time being. That man is jeopardizing his life every month he puts off operation. The continued slow, insidious infection is affecting every muscle in his body, making them less elastic, and that important muscle, the heart, is affected very soon. Myocardial changes begin and go on. If one examines the urine of such a patient he will find always some evidences of the changes in that organ. There will be hyalin, hyalogranular casts, and sometimes epithelial casts. There will be albumin; there will be a diminution in the function of the kidney to excrete, and that adds a new intoxication. By and by, he has arteriosclerosis, with interstitial nephritis, and

Bright's disease is engrafted upon the cholecystitis or cholangeitis. The individual's life, in other words, is threatened by infection that has been going on for years, not severe enough to make him give up the fight, because the physician or surgeon has not recognized the necessity of surgical cure.

I have been interested in this subject for a good many years. I have been studying the focal infections in relation to the systemic diseases, not only as relates to the gall-bladder, but as relates to the appendix as well. A chronic septic appendicitis needs operation not only because it disturbs digestion, but needs operation to relieve the individual of the degenerative changes incident to the chronic poisoning. So I have my patients operated, if I can command them, and usually they are commanded if they are my patients.

DR. ARTHUR DEAN BEVAN: I have been very much interested in Dr. Gerster's paper. He has opened up a very interesting subject. There is one thing I would like to discuss particularly in connection with this subject, based on my clinical experience, and that is, why do we fail to cure a certain number of these cases of gall-bladder and bile tract infection when we operate upon them? From my experience I should divide this answer into three parts. First, why in a given case, or in a group of cases, where we have operated for gall-bladder or bile tract infection, have we failed to cure the patient? In the greatest number of our cases we have overlooked the stone, and that is the cause of failure. In my own clinical experience, that furnishes the great bulk of the cases of failure after operation for gall-bladder and bile tract surgery.

I imagine, from Dr. Gerster's experience and from his paper, that that has been his experience as well. What is the moral? The moral is, in an operation for gall-bladder and bile tract trouble you must have a very wide exposure. You know how frequently in the late days, when the gall-bladder was operated on by a two-step operation, the patient was not cured because it was a very incomplete operation. I quite agree with Kehr when he says the secret of success in gall-bladder and bile tract work is the wide exposure, not invariably, but certainly. When it is needed, you must make an exposure wide enough to introduce the entire hand to go over fully and completely the bile tracts *in toto*. The second reason for failure to obtain a cure in these cases, is that we have made a mistake in diagnosis. It has not been the gall-bladder and bile tracts that are at fault at all. It has been a duodenal ulcer that has not been recognized; it has been the appendix; it has been the kidney; and the surgeon operates upon the case with the fixed idea that he has gall-bladder trouble to deal with, and he examines the gall-bladder and finds no stone, and proceeds at once to drain it, and the after history of the case shows he has been mistaken; that the case is one of duodenal ulcer which gives one essentially the same clinical picture. You are all familiar with the fact that in a certain number of cases it is impossible to differentiate between duodenal ulcer and the gall-bladder or bile tract lesion. A third group of cases, I think, is furnished very clearly by Dr. Gerster's paper, and that is the group of cases in which you have an infection of the gall-bladder, but no gall-stones. To my mind this is one of the most difficult problems that I am confronted with in this line of work. I never feel satisfied, when I operate upon a case and find no gall-stones and find no other lesion to explain the symptom-complex, that I have a case of infection of the bile tracts to deal with until the after result shows drainage has cured the patient. I do not think this is at all a simple matter. I think that infections of the bile tract are common. I quite agree with Dr. Gerster and with Riedel and Naunyn, and the men who have studied this subject fully, that infection is a very frequent—I should not say invariable—accompaniment of gallstone attacks, but it is a certain frequent accompaniment of gall-stone attacks. In the gross picture of infection it is simple. If you operate upon an empyema of the gall-bladder, and find a gangrenous spot, and you find no stone, you have no question at all but what you have found at the time of the operation the actual cause of the difficulty. When you operate upon a gall-bladder and you find when you open the gall-bladder that you have mucus and tarry bile, and purulent material, and gross evidence of change, great thickening of the gall-bladder, and of the ducts, there is no question but what you have in that particular case, in the absence of stone infection, a condition which is capable of having produced the symptom-complex. But when you open up the gall-bladder and you find no adhesions, and you make an incision into it, and there is the so-called strawberry appearance of the mucous membrane, and the bile is a little bit black, and you find no stone and find nothing else to account for the symptom-complex, I want to say to you, you have nothing like a clear picture to deal with, and I never feel at all sure that the patient is suffering merely from an infection of the gall-bladder unless months after

the drainage I find the whole picture clears up. In other words, I believe with Dr. Gerster that this subject requires a great deal of further study.

I want to close, Mr. Chairman, with just this practical statement in regard to what to do when you have one of these cases and you have the belly open and rubber gloves on, the patient anæsthetized, etc., and you have made a diagnosis of gall-stone disease or bile tract infection; you have opened up the field, you look at the gall-bladder, and you find no stone. You examine the cystic duct and you find no stone; you examine the common duct and you find no stone. What is the next thing to do? Open the gall-bladder? Not by any means. The next thing to do, is to go over the belly and see if you have not made a mistake in diagnosis, and see whether there is not a duodenal ulcer, or whether the appendix is not responsible for the trouble; and only in the event you do not find some other definite explanation for the symptom-complex are you at all warranted in assuming you have one of those subacute infections of the gall-bladder to deal with that gives very little macroscopic evidence of its action. It is only in that case that you are warranted in draining the gall-bladder, and then I say, the proof of the pudding is in the eating. Wait and see what the after result will be.

Dr. John B. Murphy: I cannot say that I have anything to add to this admirable presentation of the subject by Dr. Gerster. It is just the kind of paper I expected to hear. It is just the method of reasoning and the handling of a surgical subject that has been characteristic of Dr. Gerster since he wrote a little book on surgery in 1888. The most conspicuous illustration of his splendid reasoning powers, the one thing that showed at once that he is a master pathologist, was his dissertation on a felon. His presentation of the complications and not of the usual lesions that we encounter in gall-bladder surgery in the late lesions of cholecystitis, accentuates what Dr. Billings just stated—that the time to treat lesions of the gall-bladder is at the time of the manifestation of the first evidence of the existence of infection, or the presence of gall-stones.

As to the relation of infection of the gall-bladder to infection of the alimentary tract and the hæmatogenous origin of such infections, that is not quite so clear to me as it appears to be to Dr. Gerster. I believe that hæmatogenous infections, through the portal circulation, are much more frequent than those that come directly from the duodenum. At one time, I believed that a true hepatic colic never occurred except from the presence of a foreign body within the duct; that it never occurred with a pancreatic lesion; that it never occurred as the result of pressure from a tumor without; that the colic, and not the pain, which is the typical thing, was the sequence of the passage of a foreign body. I have changed my mind about that. I know that there are exceptions to that — at least, I have looked for the foreign body and have failed to find it. I agree with Dr. Bevan that the frequency of recurrence is due, above all other things, to a remaining calculus. The reason for this, however, is not an error in diagnosis, because we have more frequent recurrences in the cases in which we find stone present than in the cases in which we do not find a stone present. It is due to the fact that we have not drained the gall tracts sufficiently; that we are closing up these tracts too early, and if you examine these cases frequently, you will see large masses of mucus and pus escape through the drainage tube. After you have taken out the drainage tube, these patients have recurrences of colic that are caused solely by the masses of mucus and that will continue to form sometimes for weeks and months, and then subside entirely. The jaundice in these cases is always of a very mild type, never of the icteric type, as when the stone is in the common duct. Colic is a definite, clean type of pain, and in the enormous percentage of cases of cholelithiasis I have interpreted it as being due to the progression of a foreign body in the tract, not to its remaining stationary. A patient may have an hepatic calculus for months and years without having an attack of colic. When the stone commences to advance, and the patient has a second attack of jaundice, then he has a colic. With the cessation of the colic, the attack is over, so that I have always felt there was a clean-cut relation between the two.

There is another element in connection with the fever, which I interpret somewhat differently from Dr. Gerster, and that is the manifestation of infection in cases where the small biliary passages were not involved. I am not interpreting elevation of temperature, with icterus, as a manifestation of that infection. I recall one case in which there was no involvement of the common duct at all. And not alone in the stone cases, but in the cancer cases where you have opened and drained the gall-bladder, you have the most wicked infections, chills and fever, where there has not been jaundice or stone in the common duct, but where the irritation involves the lymphatic zone of the cystic duct, and the lym-

phatic zone of the neck of the gall-bladder. These cases give a pronounced type of infection, and we know they are not of cholangeitic origin. They must be interpreted on the same basis, I believe, as the manifestation of a number of attacks of chills and fever associated with icterus; namely, that the trouble is due to ulceration and abrasion produced by the stone and the absorption of the infective products, as accentuated by Dr. Gerster. When you take out that stone the irritation is stopped. In cases of stone in the gall-bladder, there may be a high temperature, even with drainage, which means that the elevation of temperature is not due to the pus products that are held under tension, but to the presence of a foreign body in the rich lymphatic zone, causing ulceration. The repeated recurrences of chills and fever are common in that type of lesion.

Dr. A. J. Ochsner: Many years ago the same logic and the same philosophy that we have heard to-night drew me to Dr. Gerster's clinic, and since that time I have felt the same attraction year after year. There is no teaching in the surgical field that has been more valuable, more fascinating than that which I have experienced in Dr. Gerster's clinic. You feel that all of his teaching has been reasoned out systematically and that you can build upon it.

Gall-stone surgery has been fascinating to me, and I have enjoyed the study of gall-stone surgery from its beginning, and have come to the conclusions set forth in Dr. Gerster's paper, not as clear nor as perfect as those that have been expressed by the essayist. I believe in almost every case of gall-stones a careful analysis of the history will carry one back to a primary infection of one kind or another. I have, in my own work, in almost all cases been able to satisfy myself at least of the particular form of infection in a given case. The first infection, I believe, is almost always through the circulation and almost never through the duct primarily. After the gall-stones have been formed, and after the gall-stones have passed, and after you have gall-stones which are lodged in some portion of the duct, then I believe we can trace the secondary infection in many instances to the alimentary canal through the duct. But the primary cause or causes, I believe, we can always trace, in cases in which it is possible to get a definite history, through the blood—most commonly through the portal circulation.

As regards the last part of the paper, I would say that I believe the best illustration of the effect of the papillæ upon the muscular system of the tract we can have is this: In a very large number of cases I have observed this fact, that so long as there is something in the stomach, so long may we have gall-stone colics. So soon as there is nothing in the stomach, the gall-stone colic stops, no matter how severe it was before—even though you could not stop it with one or two grains of morphin given hypodermically, except for a short time. If you wash out the stomach three or four times in succession, so that it is absolutely empty, so that there is not even mucus left, the gall-stone colic will subside, and will remain away so long as there is no accumulation in the stomach. If it returns, then you can conclude that there is mucus in the stomach. The effect of the passage of mucus past the papillæ causes contraction of some portion of the biliary tract, the common duct or gall-bladder, and you have a spasm. Now then, that spasm in turn increases the œdema, the œdema increases absorption, and a combination of these conditions increases the cholangeitis. Acute cholangeitis is a temporary condition. If you stop these conditions by stopping the spasms, the œdema will subside, and the drainage is re-established. The spasm disappears, and as soon as you have established drainage the cholangeitis subsides. From a practical standpoint that is very important, because in cases of acute cholangeitis, resulting from impaction and from complete obstruction, if you bear this fact in mind, an immediate operation, which is a serious matter, is almost never indicated, because in a very large number of cases in which I have found that condition, the colic has subsided entirely. The surrounding tissues have taken care of the infection, and a perfectly safe operation was possible afterwards.

Dr. M. L. Harris: I wish to express my great appreciation of having the opportunity of hearing this very complete paper, and I do not wish to take up your time by reiterating what has been said. However, I wish to express my belief in the hæmatogenous origin of these infections. I believe it is the rule in the great majority of cases that the infection is of hæmatogenous origin. We know that if organisms are injected into the blood — for instance, into the jugular vein — that they will appear in the bile within three minutes almost invariably, and can be obtained from the gall-bladder, on an average, within five minutes. We also know that the virulence of these organisms, when re-collected from the gall-bladder or the bile, may be altered by the condition of the liver during the time when they were eliminated. In other words, if the

liver is perfectly normal, if it is carrying on its function normally, is not interfered with by congestion, or by a superabundance of toxins to be eliminated, the organisms will go through with the virulence very much reduced; but if the circulation through the liver be interfered with, if it be congested, or if a large amount of toxins be introduced into the blood at the same time, so that the work of the liver is hampered, the organisms will go through with their virulence very marked; in other words, not reduced by being eliminated by the liver. That will explain why we will get cholangeitis from the elimination of the microbes by the liver during other diseased conditions, or when the circulation through the liver is hampered as during pregnancy, when it is compressed, or by dietetic errors, or disturbances of the intestines and stomach.

Another point, which I wish to make, is the necessity of more prolonged drainage. There is only one safe rule to guide us in the length of time in which the gall tracts should be drained, and that rule is until the bile flows perfectly sterile. If we would make very frequent cultures of the bile, we would know better when to stop drainage. Another thing, the organisms sometimes will not be obtained in the flow of bile, but may be obtained by removing the secretions from the mucous membrane. For instance, if you make a culture from flowing bile, you may not get organisms, but if you take a loop and scrape it over the mucous membrane you get cultures. These cases are in the majority of instances hæmatogenous infections, and we should drain until the bile flows sterile.

Dr. Daniel N. Eisendrath: I think there are two things that stand out prominently in the paper of Dr. Gerster to-night, and these are what we have learned in the recent pathology of the gall-bladder; that is, there are two factors in the etiology of gall-stone formation. The first is stagnation, and the second secondary infection.

Dr. Gerster has ably pointed out how a simple inflammatory swelling of the bile passages and the mucous membrane of the duct can cause such a mechanical obstruction, and that stone formation can take place in sterile bile, as has been shown by several experiments.

The question of infection is one we have great difficulty in overcoming, because we have an analogy in the kidney. There are a number of cases of kidney infection in which, after the removal of a stone, the stone will re-form. That is the experience of all who have had more or less to do with kidney surgery.

There is another point Dr. Gerster has mentioned, and that is the reason for the recurrence of calculi, or at least, when we find them so frequently, our operations are unsuccessful simply because we have overlooked them. That is to a certain extent the case, but there are a considerable number of cases in which two other factors are overlooked, and this brings us into close relation also with the question which he brought up, and that is the relation of cholecystostomy to cholecystectomy.

The two other causes, to which he referred, are shown in the beautiful work of Aschoff and Beckman. In the microscopic examinations of gallbladders, the so-called Luschka's ducts are not infrequently the seat of recurrences of stone formation. Aschoff has shown by the section of a large number of gall-bladders removed during operation that these Luschka's ducts, which vary in depth or penetration of the wall of the gall-bladder from being simply submucous, penetrate all structures which pass to the serous coat. In some of the specimens, he found a beautiful deposit of cholesterin, and this accounts for the recurrences in some cases. I have had occasion within the last two months to remove such a gall-bladder and found such a stone beautifully located, which undoubtedly would have been overlooked, and would have counted as a recurrence due to an overlooked stone after the gall-bladder had been removed.

In a second case recently, I found, from such a Luschka's duct, there was ulceration into the liver bed closely adjacent to the gall-bladder.

A second cause of recurrences has been shown beautifully in a specimen I examined for Dr. McArthur, and that was an intrahepatic formation of gall-stones. There have been a number of such cases reported. For instance, Dr. Poore, of New York, during an observation of sixty autopsies on cases of cholelithiasis in an autopsy room in Vienna, found in eight of them there were intrahepatic formations of calculi. Thus we can see a direct connection of the formation of calculi in the liver to this zone. There were three in the liver in Dr. McArthur's case, the calculi varying in size from a pin-head to almost a pea. In Poore's article he speaks similarly.

There is one thing that stands out prominently in Dr. Gerster's paper; and that is, prolonged drainage is our only hope. I take it, the majority of us are careful in looking for calculi, and that we follow his dictum of not depending upon palpation alone for finding calculi, and we can only hope that by prolonged drainage and guarding against intrahepatic infection and removing all

causes of stagnation, we will avoid the recurrence of stone.

DR. GERSTER (closing the discussion): I am delighted that my paper elicited such a free discussion. I am very grateful to all of you for having listened so attentively to my reading of such a long paper.

Dr. Bevan's remarks regarding a wide exposure were of the utmost practical importance. I have, ever since the beginning of my surgical work, insisted, contrary to the opinions of others, on making a sufficiently large incision to enable me to do the work under the guidance of the eye, whenever possible. A surgeon should never perform an operation without the guidance of the eye unless he cannot help himself. It is bad enough then to do the work blindly in a dark place. When a surgeon works in the dark of his own choice, and without necessity, he is committing what, according to Catholics' phraseology, is the greatest sin; that is, a sin against the Holy Ghost. He is depriving himself of that light which ought be his guidance. It is inane to talk about the tactus eruditus as a substitute of the sense of sight, and thus to avoid making an adequate incision. The index finger has no eyes, and the senses of sight and touch are here not to exclude, but to complement, each other. The man who makes too small an incision is running unnecessary risks. Many a patient has lost his life through accidental injuries inflicted through too small an incision. I have seen operations for appendicitis done through a one-inch incision, where in the presence of a half rotten and adherent appendix, after a good deal of digging and tearing with the finger, feces, blood and pus were seen to escape through that little incision. My criticism of this kind of procedure was met with the statement that there was no ground for criticism because the patients recovered. I admit that some of them recover in spite of the procedure; but of those that do not recover, we hear little or nothing. The principle of working under the guidance of the eye, wherever it can be done, is one of the most essential and sound ones. Clear insight will safeguard you against such accidents as these are: injury to the stomach, the duodenum, to the hepatic artery or the portal vein — errors, some of which can be avoided but never repaired. Fortunately, the great majority of modern surgeons do not believe in performing operations through very small incisions. Subsequent herniæ do not depend upon the length of the incision, but are due to avoidable nerve injury.

I wish to thank Dr. Billings for the interesting way in which he discussed my paper and for his compliment in calling me an "internist." I do not advocate operation in every case of catarrhal jaundice. The judgment of the medical man must tell when an operation is indicated, and when it is not. I stated that the vast majority of cases of jaundice are such that never reach the hands of the surgeon. Why? Because they get well with internal treatment, with simple treatment, such as dietary management, rest in bed, and so forth.

Dr. Murphy made a distinction between fixed pain and colic. That distinction is very important. The patient who had a cigar-shaped stone was able to give a correct and precise description of the course of her malady. Her statements were confirmed by her daughter. Hers was a very well observed case. That woman had had only two real attacks of biliary colic. These attacks were accompanied by transient jaundice lasting a few days only. The first attack occurred a number of years ago, the second attack in the hospital, three days before operation. During the interval, she had the pain characteristic of gastric ulcer located in the pit of the stomach. Dr. Ochsner mentioned that the entrance of acid chyle into the duodenum starts the biliary colic. Undoubtedly, this does occur, and is the cause of the great difficulty of differentiating between ulcer and gall-stone. Both, however, are often enough co-existent.

There is another point which interested me very much. It was brought forward by Dr. Murphy, and deserves attention. There exists in one respect an analogy between the morbid processes accompanying cholangeitis, and those observed in appendicitis. I refer to the lymphangitis that accompanies both these diseases when ulcerative destruction is present. Whenever there is an ulcer, lymphangitis is also present. Such a lymphangitis may become exaggerated into a true phlegmon, which is far more dangerous than the inflammation of the duct or that of the appendix. We can get at the appendix, we can deal with peritonitis which is involving the peritoneal surface alone. By stopping the visceral leak, by removing dead structures and by draining the infected areas, we can check the morbid process. But when destructive inflammation has penetrated the subperitoneal layers, causing extensive septic lymphangitis, and septic thrombophlebitis, the condition gets beyond surgical control and becomes hopeless. These are the cases which formerly we classified as "dry peritonitis" or "peritoneal sepsis," vague terms which may

now safely be abandoned. Pathologists looked at the surface of the peritoneum and did not go beneath it to examine the subperitoneal structures. The peculiar phlegmonous process, the thrombosis of the roots of the portal veins, escaped their notice. In looking for these conditions, we frequently find them, and are occasionally able, when they are fresh and circumscribed, to split open the veins, and free them of septic thrombi, to drain the affected phlegmonous area and to save the patient. If the process is widespread, all our efforts are baffled by acute sepsis or by pylephlebitis. Exactly such conditions may take place about the biliary ducts as well as about the appendix. They are extremely dangerous, keep up fever in the absence of icterus, and on account of their wide distribution, baffle all efforts at effective surgical relief.

Regarding the view that biliary infection is always hæmatogenous, I confess my inability to arrive at a conclusive decision, as I am not a learned pathologist. I may state, however, that experts admit hæmatogenous infection as a rule in typhoid cases. On the other hand, precise and easily made examinations have proven that in the vast majority of cases the bacillus coli was the infecting organism. It is invariably found in small numbers in the normal bile of the healthy individual contained in the duodenal end of the common duct.

Dr. Eisendrath mentioned intrahepatic stone. I have seen it many times. The question has been raised whether or not all the stones found in the common duct are of cystic origin; that is, whether they are all formed in the gall-bladder, descending from there into the common duct, or not. This question has been debated and was decided to this effect, that most of the stones found in the common duct come from the gall-bladder. This does not, however, exclude the formation of stones elsewhere. Why should not stones form in the hepatic or common duct, whenever the same conditions of stagnation obtain there that produce stones in the gall-bladder?

I wish to thank you once more for the courtesy you have extended to me.

CORRESPONDENCE

ON THE TEACHING OF OBSTETRICS

By GEORGE CLARK MOSHER, A. M., M. D., Kansas City, Missouri

WHEN the admirable paper of Dr. J. Whitridge Williams, on "The Teaching of Obstetrics and the Midwife Problem," was presented to the Association for Prevention of Infant Mortality last November, a distinct step forward was taken in the matter of medical education. That this address should excite some criticism was to be expected, since the materials were handled without gloves and the data from which his conclusions were drawn came from the teachers of obstetrics throughout the country and represented the average standard of present day instruction, of which none of us can feel very proud.

The fact that Dr. Williams is frank enough to admit that the instruction at Johns Hopkins does not meet his approval as being ideal, should of itself make the criticism he passes on the profession of teachers of midwifery impersonal and not an arraignment of any particular institution nor its faculty. As to the disclosures which we voluntarily made, in reply to the questionaire which he framed as a basis for his paper, especially where the admission is made that some of us have had to do obstetrical practice to make a living — not having university positions with generous salaries attached — still in many instances I believe we have turned out men who by their personal efforts have mastered the rudiments of obstetrics and by practice and post graduate work have equipped themselves to become obstetricians, fully entitled to the name and not to be classed as man-midwives if the latter is a designation of opprobrium.

That these conclusions are not theoretical, is demonstrated by the fact that, as one of the staff engaged in conducting examinations for the admission of graduate internes to the Kansas

City General Hospital, I have had unusual opportunity to compare the papers presented by men from all the schools which have annually entered the competition. This year nearly one hundred and fifty applicants, representing twelve leading colleges in all the teaching centers, have been examined. The findings will bear out my contention. It is, after all, the individual student who makes his own record. Other things being equal, the best man having the best instruction, turns in the best paper.

When with Dr. Reuben Peterson, I made the analysis of the methods of teaching obstetrics for the American Medical College Association, in 1910, we were struck with the variety of the standards recommended for this department, in the various institutions making reports to the Association. The most concise and clear suggestion, contained in the report, being the one on the subject of teaching obstetrics which Dr. DeLee submitted to the Committee of One Hundred for the Council on Education for the American Medical Association and this should be read and digested by every teacher and also by every practitioner who does any obstetrical practice. He will be impressed by the dignity of his calling and the gravity of the problems he assumes to solve, and look forward to the coming of the better day in both teaching and practice of obstetrics which is foreshadowed in Dr. Williams' scholarly address.

The future teacher of obstetrics should be all that the distinguished Professor at Hopkins demands. The laboratory instruction and the preliminary work in collateral sciences tend to broaden the grasp of the student. The fourth year man should be obliged to have seen his quota of cases. Still, in addition to all this necessarily pedagogical advantage, I believe that no man should go out into practice without a fifth year of hospital instruction, of which three months should be in the obstetric wards.

The work of Dr. Williams will be better appreciated when we come to standardize the obstetrical service now offered to an unsuspecting pregnant public. In the meantime, post-graduate facilities may be found in the great teaching centers and those who have graduated without these advantages may avail themselves of the service of the heads of the clinics of the metropolitan hospitals where abundant material is found.

One of the most significant signs of this, showing the attitude of the practitioner doing obstetrics, is the storm of protest by numerous correspondents against the technique recommended by a recent writer in the Journal of the American Medical Association on "The Management of Normal Labor," a great deal of this criticism coming from the men doing country practice.

Whether obstetrics will ever become a specialty in the same sense that opthalmology, neurology and a few other branches have, is a question for the future to determine. The general practitioner calls an internist for diagnosis, a pediatrician for a formula for feeding his infant patients and more and more avails himself of the obstetrician in his difficult labor cases. This last recognition is slow of growth and still it is becoming more and more the custom, especially among those whose training teaches them to realize the importance of the obligation assumed to bring safely through the ordeal two patients who are peculiarly susceptible and whose welfare is so dependent on the skill and judgment exercised at the time of the accouchement.

In the meantime, while we strive to raise the standard of teaching obstetrics and thus improve the technique of delivery to be employed in the birth of the coming generation, let us hope that Lea of the next forty years cannot say that mortality of the lying-in has been reduced by but a fraction of one per cent in forty years!

EDITOR SURGERY, GYNECOLOGY AND OBSTETRICS: I am preparing a monograph on tumors and diseases of the omentum, and wish to either purchase or secure gross specimens, microphotographs, drawings or sections of this structure. Credit will be given to the physician from which they are secured. A competent pathologist, in the laboratory attached to my office, will take the gross specimens, work them up, make a laboratory report, and return remnants of specimens, if so desired.

HUGH CROUSE, M. D.

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BOOK REVIEWS

BLOOD VESSEL SURGERY AND ITS APPLICATIONS. By Charles Claude Guthrie, M. D., Ph. D. London and New York: Longmans, Green & Co., 1912.

Blood vessel surgery has now passed beyond the stage of laboratory consideration and taken its place in the surgical armamentaria. This volume by Guthrie, who has been identified with the early experimental work, is a valuable contribution to surgical science. It deals in its various chapters with the technique of operations, morphological results, biological considerations, anæmia and hyperæmia and their effect upon tissues, with an extensive discussion of the transplantation of tissues and effect of the alteration of circulation upon various organs.

To one who wishes to understand the basal principles of blood vessel work this book is essential. It contains certain things which the science of blood vessel surgery in the future may abandon, but the work is so valuable and so apropos that it should have a wide distribution. This volume of 350 pages with closely written text and a moderate bibliography will be valuable to all students.

SEX HYGIENE FOR THE MALE AND WHAT TO SAY TO THE BOY. By G. Frank Lydston, M. D. Chicago: The Riverton Press, 1912.

The need of a popular treatise on sexual hygiene, which should be at once authoritative and free from cant and quack suggestion, has long been felt by physicians, teachers, and more particularly by progressive laymen who recognize the value of instruction of youth in such matters. Dr. Lydston's book, whose title appears above, certainly seems to fulfill this demand. No suggestion of drugging or medical self-treatment can be found. The book is written to aid the profession in attacking the evil of ignorance and quackery and in converting ignorant patients into intelligent ones.

The author very aptly states a truism that we frequently overlook in considering this question, viz.: that education in sex hygiene at present must begin at the top. The parents, the teachers, and other adults must be taught first, the young person afterwards.

In reading this book, which treats of a subject that is usually considered a delicate one, the reviewer is struck by the high-minded and wholesome manner in which the matter is handled, which converts it into a matter-of-fact theme discussed in a scientific way.

The author makes it plain at the outset that a wholesome mind can only be found in a strong body, that is, one trained to physical exercise. Several chapters are devoted to the details of training the body and health building. After discussing this part of his subject, the author devotes several chapters to the consideration of venereal conditions in a scientific manner that will appeal to the more intelligent class of laymen, and instructs them to carry all problems that are not entirely clear to their family physician rather than the quack advertiser.

PLASTER OF PARIS AND HOW TO USE IT. By Martin W. Ware, M. D. New York: Surgery Publishing Co., 1911.

This second edition, with ninety illustrations, is revised and enlarged and gives the author's conclusions and suggestions in the use of plaster of paris. It is based upon the author's rich experience in the treatment of joint disease and fractures. This little book will serve as a valuable guide to the beginner and also suggest many points of value to those more or less familiar with the uses and behavior of plaster of paris. H. A. POTTS.

THE DISEASES OF CHINA. By W. Hamilton Jefferys, M. D., and James L. Maxwell, M. D. Philadelphia: P. Blakiston's Son & Co.

This work, while not in any sense a general text book of medicine, cannot fail to be of vast assistance to medical men working in China, both Chinese and foreign, presenting as it does a concise account of the special diseases to be met with in that empire. A complete account of many of the diseases included might be obtained from the voluminous literature of tropical medicine. However, they are here presented in one volume of reasonable size and with constant and special reference to their modifications as brought about by the hygienic habits and racial peculiarities of the Chinese. It has been possible only to allude here and there to questions and studies arising out of this vast and promising field for comparative medical research, the disproval and establishment of medical theories by reference and comparison with the conditions and findings under widely differing civilizations. Such questions are raised under discussion of the etiology of beri-beri, the relation of carcinoma and gout, plague infection, and at many other points, but this field is enormous in possibilities for future usefulness and would warrant the attention of special research workers.

This work is illustrated very largely by photographs of diseased conditions among the Chinese; most of them are of the authors' taking and the majority have never before been published.